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Contents.

	PAGE
Skill in Industry	371
Machine Cast Pig-iron	371
Correspondence	372
The Institution of Chemical Engineers	372
Random Shots	372
Whiteheart Malleable Tests	373
Scottish Foundrymen's Dinner	373
Ingot Mould Design	374
A Postponement	374
A Footballer Injured in Foundry Mishap	374
The Works of Altos Hornos de Vizcaya, Bilbao, Spain	375
Economies in Oxy-Acetylene Cutting for Riser Removal	376
Bardenhene and Zeyen's Paper Criticised	377
Book Review	378
A Note on the Vitreous Enamelling of Cast Iron	378
A Short Paper Competition	379
Magnesium as a Foundry Metal	381
John Wilkinson Medal Awarded	381
Pleasant Surprise for Derby Foundry Workers	381
Foundry Purchasing—XXIX	382
Newark Firm's Better Year	382
Urgent Cylindrical Casting Made in Cores	384
Newark Prize Distribution	384
Trade Talk	386
New Companies	386
Contracts Open	386
Personal	386
Reports and Dividends	386
Falkirk and the Light Casting Industry	388
Iron and Steel Markets	388

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

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Forthcoming Events.

NOVEMBER 27.

Institute of Metals (*Birmingham Local Section*):—Joint meeting. "Electric Furnace Developments," Paper by D. F. Campbell, M.A., A.R.S.M.

Sheffield Metallurgical Association:—Ordinary meeting at Sheffield. "Fighting Corrosion," Paper by T. Henry Turner, M.Sc.

NOVEMBER 30.

Institution of Mechanical Engineers:—Thomas Lowe Gray Lecture in London by Professor William E. Dalby, F.R.S.

DECEMBER 1.

Institute of Metals (*Birmingham Section*):—Annual dinner.

Institute of British Foundrymen.

NOVEMBER 24.

East Midlands Branch:—Ordinary meeting at Leicester. "The Engineer and the Foundryman: What's Gone Wrong?" Paper by W. H. Poole.

NOVEMBER 30.

London Branch (*Junior Section*):—Ordinary meeting in London. "Copper and its Alloys," Paper by L. H. Howell.

DECEMBER 1.

Lancashire Branch:—Ordinary meeting at Manchester. "Venting of Dry Sand Moulds," Paper by E. Flower.

West Riding of Yorkshire Branch:—Ordinary meeting at Bradford. "Shrinkage Holes in Small Grey Iron Castings," Paper by P. A. Russell.

Wales and Monmouth Branch:—Ordinary meeting at Bristol. "The Influence of Tests on the Design of Engineering Castings," Paper by J. G. Pearce.

Skill in Industry.

We referred recently in these columns to a discussion on skill in industry before the British Association at Glasgow, and in particular to some remarks of Mr. C. G. Renold. These were intended merely to illustrate the question of skill as he viewed it, but they included some information of the highest possible value in the application of scientific management, and the results are worth special attention.

He said that his factory had for the past fifteen years been going through the process of development on the lines of scientific management. That is the first point. Scientific management is not installed in five minutes. It depends for its success on a continuity of policy, and more than anything eles it evolves from an attitude of mind to industrial problems.

The second point is that, taking analyses of employees in 1913, 1927 and 1928, he had found that the *craftsman category had increased both in numbers and in percentage of the whole.* In other words, scientific management displaces the unskilled and semi-skilled rather than the skilled man, owing to the use of more elaborate machinery and transport systems. This movement had taken place in the office as well as the works, owing to the use of office machinery.

Although the fifteen years between 1913 and 1928 had seen a revolution in manufacturing processes, clerical and statistical methods, and in organisation, the *proportion of skill in the industry was practically constant.* In spite of the efforts to replace skill by machine and to subdivide complex skills into simple ones, the result was that the skill required on the whole was virtually the same. It might be asked then whether scientific management is not a failure, since the attempt to base it on skill elimination had failed.

The answer to this was given by showing the production per head. In 1928 there were 1,807 people, containing 34.9 per cent. of the skilled, producing in *value two and a-half times as much per individual* as a group of 1,256 people in 1913, containing 36.7 per cent. of skill. Prices in 1928 had got back to the 1913 level, but wages were substantially above the 1913 level. The increase in productivity, measured by selling value, had not quite compensated for the increase in wages, and the benefits of the increased efficiency had gone to the public in low prices and the employees in high wages.

This directly supports our reiterated conviction that increased wages can only be provided out of increased production, and that increased production provides the means for paying high wages. And modern methods in industry demand just as high a proportion of skill of one kind or another as was needed previously.

These results respond to the best test for scientific management; contented workers; high wages; low prices. Such an industry deserves to earn large profits. We propose to consider later the recent Census of Production to see what industry in general has to show for a similar period to that covered by Mr. Renold's figures. The result will be as disturbing as his figures are consoling.

Machine Cast Pig-Iron.

The advantages of machine cast pig-iron are so manifest that it is difficult to understand the reasons for the delay in the application of machine casting systems to the production of foundry pig-iron in this country. It is a very common error to attribute this primarily to the reluctance on the part of foundrymen to depart from the familiar standards of fracture established for sand cast pig-iron. Many ways are available in which the grossness of this error can be demonstrated, the most pertinent of which is the fact that many thousands of tons of machine cast pig-iron have been used in British foundries with complete success. In the common grades of foundry pig-iron the difference in appearance between the fracture of the common type of machine cast pig-iron and sand cast pig-iron is generally exaggerated. It is by no means so great as is imagined. Coupled with this, machine casting systems, involving, as they do, a receiver or mixer ladle, ensure a greater degree of uniformity in individual casts of pig-iron that is generally met with in sand cast pig-iron in this country.

In point of fact the primary object of machine casting in the form of the modern systems extensively developed in America is to enable the large outputs of the blast-furnace plants to be dealt with expeditiously and economically. The principal cause for the delay in the adoption of such systems in our own country is entirely a matter of the conditions, practical and economic, under which blast-furnaces operate in this country.

If any educational campaign is considered necessary by foundry purists to foster the development of the use of machine cast pig-iron in the foundry here, it must be directed towards the blast furnaces and their auxiliary services. If any such campaign is supported by the demonstration of machine casting plant economically successful under the conditions of the production of foundry irons in this country, we are sure that the campaign need not be a strenuous one.

We feel it a duty to have taken this opportunity of relieving the British foundrymen of the responsibility of this one sin of omission.

XUM

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Transverse Tests.

To the Editor of The Foundry Trade Journal.

Sir,—The first editorial in your issue of November 15, referring to the transverse and other tests for cast iron, raises a question which might, with profit, have been aired in the discussion of Mr. Pearce's recent paper. The relation between the transverse and tensile tests is discussed, and the factor 1.8 to 2 is mentioned as the ratio between the results obtained in the two tests. Continuing, it is stated that this factor is variable, because the transverse test is made on the full section of the bar, whereas the tensile test is made only on a machined part of the section. This is taking for granted that the two tests are measuring the same property in the iron, and can therefore be directly related; but is this strictly the case?

I think that some well-known experts in the cast-iron world will agree with me that the two tests do not measure absolutely the same property, and I well remember showing one of these some results in which, by modification of a high-quality iron, its tensile strength was increased at the same time as its transverse strength decreased slightly, and other results are to hand in which a reverse tendency is shown. These results were obtained on a number of test bars, so that the variations are beyond those expected in normal experimental error. In these cases the modification of the iron is causing a regular variation in the ratio of the results obtained in the two tests.

It is conceivable that the ultimate strength of a bar in transverse test is determined not only by its tensile strength, but also by its elasticity; for as Mr. Pearce has admitted, during the transverse test the relative distribution of stress varies, along with the movement of the neutral axis across the section of the bar, and it seems reasonable to suppose that the movement of this axis is determined by the deflection of the bar, which, in turn is controlled by its elasticity. Thus the modulus of rupture obtained in the transverse test is dependent on both the tensile strength and elasticity of the iron. If a bar is hardened, for instance, by the addition of chromium to the iron, the tensile strength will probably be increased, but the elasticity of the bar may at the same time be decreased, giving a lower deflection and a corresponding alteration in the relative distribution of stress in the section, which will quite conceivably result in a change in the transverse modulus which is disproportionate to the simultaneous change in tensile strength.

What then does the factor determined by the ratio of the transverse to tensile test results really mean? It seems possible from the above consideration that as it is determined by both tensile strength and elasticity, we may find in it a measure of that somewhat ephemeral property of the metal called by some "body," or by the loquacious foundryman, just "guts." At some future date then, we may not ask for tensile and transverse test results on cast iron, but we may classify its quality on the basis of tensile strength, and the ratio of transverse to tensile strengths, the latter being obtained from tests carried out under standardised conditions.—Yours, etc.,

Arthur B. Everest.

59a, Abbey Road, London, N.W.8.

To the Editor of The Foundry Trade Journal.

Sir,—Your leader of last week commenting upon above subject expresses a belief that foundrymen do not appreciate the relationship between the tensile and the transverse test. On a wide question like this it seems advisable for foundrymen and metallurgists to rely upon their own personal experience and to compare its magnitude with that of others before forming even an opinion.

Personally I possess a collection of the results of some eight or nine thousand testbars. At one time we classified them—card system—firstly, according to analysis. Namely, there was a series starting with the lowest total carbon and ending with the highest, other series respectively for graphite, combined carbon, silicon, phosphorus, sulphur and manganese. A second class dealt with transverse strength, a third with tensile, a fourth with hardness, a fifth with mixtures, and so on. Each class had sub-divisions in which appeared bars cut out of castings, bars attached by stilts to castings, bars cast separately, bars machined, etc., etc. It was a large task, and everything possible was done to arrive at reliable conclusions.

I can but say, and I believe all others in my laboratories at that time will agree with me, that we got no indication of a reliable factor which could be used to predict tensile strength from transverse results or *vice versa*. Moreover, the irons appearing in the upper and lower regions of the transverse series were not those which appeared in the upper and lower regions of the tensile series. This confirmed Professor Turner's historic work, which showed that iron giving the better transverse results was not necessarily that giving the better tensile results.

You suggest that the factor will vary with the quality of the iron. Considering so few foundries are able to control composition from day to day and year to year, and, moreover, that still fewer foundries are able to control the amount of total carbon, I would think that if the relationship between transverse and tensile strengths is reliable only when irons are similar it can be said hardly to apply to general foundry practice.

The argument is carried further in that you go on to say that this matter may enable engineers to adopt a smaller factor of safety. That would seem to be a dangerous theory unless one stresses the fact that the strength of the shaped testbar weighing a few pounds and attached by stilts to, or cast separately from, a casting of any weight—perhaps five or twenty tons—bears little or no relationship to that of the metal in the casting.

I think it highly unlikely that the engineer will alter his factor of safety until we produce tests of the metal in the casting itself. Long experience of breaking up castings and taking testbars from various parts discourages the idea that separately-cast or "stuck-on-" shaped bars bear a relationship to the metal in the casting—actually they appear to represent neither its tensile, its transverse, its hardness, its composition, its grain size, its phosphide distribution and network, its graphite, its pearlite, nor its structure generally. Is it not a scientific impossibility that it can be otherwise?—Yours, etc.,

Horace J. Young.

3, Central Buildings, Westminster,
London, S.W1, November 19, 1928.

[It would be interesting to learn whether the transverse test-bars broken were machined.—Editor.]

The Institution of Chemical Engineers.

The completed arrangements for the Conference on Drying, to be held by the Institution of Chemical Engineers, are now announced.

The Conference, which covers a varied number of subjects, will be held in the Chemical Society's Rooms, Burlington House, London, W.1, on December 6 and 7. Sessions will be held at 10.30 a.m. and at 2.30 p.m. on each day.

On Thursday morning the Conference will open with Papers on "The Seasoning or Drying of Timber," by S. T. C. Stillwell, of the Forest Products Research Laboratory, and "Tunnel and Stove Drying," by A. T. Henly. The afternoon Papers will be read on "Film and Spray Drying," by J. Arthur Reavell, and "Drying by Pressure," by Prof. J. W. Hinchley.

On Friday morning Mr. T. J. Horgan will present a Paper on "Rotary Dryers," and Mr. G. W. Riley one on "Vacuum Drying." The Conference will conclude on Friday afternoon with further Papers, but unrelated to the foundry industry.

A programme giving the full particulars may be obtained from the Honorary Secretary of the Institution, Abbey House, Westminster, London, S.W.1.

Random Shots.

The event being staged in London in June next, the International Foundry Trades Exhibition and International Foundrymen's Convention, will be by far the most important event of its kind ever organised by the industry, and strenuous efforts are being put out to make it a red-letter occasion, not only to our own people but to our foreign guests.

* * *

I find it rather extraordinary that the growth of the international foundry movement should have been so considerble in about five or six years. The industry is certainly giving the rest of the country a lead in this respect. In its way, the movement helps the League of Nations.

* * *

There is all the more cause for wonder in this because, very broadly speaking, there is not a vast international trade in castings, not, that is, between the countries participating in the conventions. Peru may have to buy pipes because she has no foundries, and for this trade the co-operating countries are often competitors. But cast iron takes up too much space and is too heavy for easy transport: it is obviously one of the first things an industrial country has to make for itself.

* * *

Where, then, have we to look for the reason for international movements in cast iron? Is it not due to the fact that it is so complex that metallurgists all over the world are anxious to interchange ideas and thought about it—to the fact that it is so difficult to handle in the foundry that men feel the need to exchange experiences and gain thereby?

* * *

One of the difficulties which has had to be faced is the fact that an international exhibition cannot be held every year. An exhibition is such a strong attraction at a foundry convention that I can understand the organisers of the latter in any country being tempted to arrange for the former. And an exhibition takes on added importance if it has foreign exhibitors. There is thus great kudos in the blessed word "international," which even Moscow has not spoiled.

* * *

The question of nomenclature is now practically settled, and in June the exhibition will be truly international, with contingents of visitors from all parts of Europe and America. We are fortunate in having the Foundry Trades Equipment Association in being to back the exhibition, while the Convention will, of course, be organised by the Institute of British Foundrymen.

* * *

A point not so well appreciated as it might be is the fact that the I.B.F., by virtue of its constitution, is debarred from holding or running exhibitions, just as a railway company is debarred from owning blast furnaces. Parliament does not like to risk granting powers which may become too great a monopoly. The American Foundrymen's Association is placed otherwise, and owes not a small part of its power and prestige to holding exhibitions. It does not require a great stretch of imagination to understand that a body undertaking financial responsibilities of the kind involved in an exhibition can consider the question of hospitality to foreign guests and convention expenditure on a scale not practicable under our conditions.

* * *

Still, our guests can be assured of a good welcome and a very good time. In this country, a good time need never be synonymous with mere expenditure of money. We want every foundryman to realise that, whatever is done by the official bodies and committee, they are only acting on his behalf, and that he is the host on this occasion.

Marksman.

Whiteheart Malleable Tests.*

By E. R. Taylor, A.R.S.M., F.I.C.

It has been the general custom in this old-established industry to prove the quality of its goods by some simple bending, twisting, or squeezing test, which, however convincing, lacks that definite measurement of strength and ductility which present-day specifications purposely seek to bring out. Typical of such evidence in the past has been the hammering to destruction or the flattening out on an anvil of any small casting taken at random. It must be understood, however, that a large branch of the industry is still concerned with the production of small wares of malleable cast iron for which mechanical tests are never needed. In fact, so long as this type of works turns out clean castings, pleasing to the eye and capable of standing some bending in the vice, the buyer is satisfied. These goods, amongst which might be classed parts of harness, small locks, cabinet-makers' requirements, etc., cannot be classed with the production of engineering malleable castings required to withstand definite service stresses. It is in this latter class that some more systematic measure of quality is necessary.

Good management, *i.e.*, selection of the correct quality of raw material, skilful casting in the foundry, careful packing in the annealing cans, and annealing or "softening" of the hard castings, should be supplemented by knowledge of the strength of the product in tons per square inch and of degrees of bend. Such evidence would not only meet the desires of the engineer or metallurgist for facts on which design can be based, but would enable the foundry manager himself to follow in a scientific manner the quality of his product and the influence of changes in shop methods.

Thin-Walled Malleable Castings.

The case of the manufacturer of thin-walled goods, *e.g.*, brackets for bicycle fittings, is interesting. His products call for sound workmanship and material of the greatest reliability. Human lives depend upon the quality of the castings when in use. The usual works method of testing such important parts is to squeeze a representative number in the jaws of a vice. Such a test always distinguishes between good and bad material, and is as convincing a test of quality as a buyer would wish to see. It is in such cases that there is a difficulty in insisting on standard tests. To ask such a maker to conform to the B.E.S.A. tests for whiteheart malleable, *i.e.*, ½-in. by 1-in. by 8-in. bar for bends, and a bar of 0.564-in. effective diameter for tensile strength is impracticable because of the great difference in thickness between this product and that of the test bar, which would require a much longer annealing period. Short annealings, as used for thin-walled castings, are wholly unsuited for annealing such a standard test bar. This is a case where the test bars would need to be annealed in an independent oven away from the very articles which they are supposed to represent. Moreover, it is questionable if the structure of the annealed test bars would sufficiently resemble that of the thinner castings manufactures. In the operation of annealing the thin castings surrounded by ore gradually lose their carbon, so that the elimination is almost complete, leaving perhaps only 0.2 per cent. total carbon in the annealed casting. On the other hand, a test bar of ⅜-in. or ½-in. thickness, after a much longer period of annealing than would be given to a bicycle bracket, might suffer such reduction of total carbon as to leave, say, 0.7 per cent. Hence the test bar would not equitably represent the brackets. A test bar of similar cross section to the actual work in hand would be more appropriate. In this case, test bars and the articles they represent could be annealed together in a thoroughly efficient and convincing manner.

This gives the manufacturer of thin-walled goods a fairer and better chance of judging the quality of his finished articles. He would further be enabled to carry out tests for tensile strength, elongation and bend, which at present are often omitted owing to the unsuitability of the standard test bar described.

A test bar, say 1-in. by $\frac{1}{16}$-in. by 8 in., would more nearly meet the case. Such a bar would be of similar thickness to that of thin-walled castings, and could be annealed along with them, receiving identically the same treatment in the oven. Definite figures of strength and bending properties could then be recorded.

The malleable trade is thus in much the same position that the grey-iron section was until early this year. A standard test bar had been devised, but experience served to show that in the nature of things it can only represent castings very near to the bar thickness. Very thin and very heavy castings require to have test bars respectively thinner and thicker than the standard bar.

In the recent standard specification for grey-iron castings (B.E.S.A. No. 321, 1928) provision is made for three sizes of test bars so that the engineer or purchaser can specify the dimensions according to the main cross-sectional thickness of the castings represented.

It would appear advisable that some such provision be made in regard to malleable castings. The following table is therefore drawn up tentatively in order to show what might be done in this direction:—

BEND TESTS.

Test bar.	Dimensions.	Main cross-sectional thickness of casting represented.
	Inches.	
S	$\frac{1}{16} \times 1 \times 8$	Not exceeding ¼-in.
M	$\frac{3}{8} \times 1 \times 8$	Over ¼-in. thick and not exceeding ½-in.
L	$\frac{1}{2} \times 1 \times 8$	Over ½-in. thick.

While a bend value of 45 deg. might reasonably be expected from bar M, a greater bend would be expected from bar S, and a lesser bend value from bar L. These could be standardised by actual trial, together with the radii of the mandrels round which the bend takes place.

In regard to tensile values, the B.C.I.R.A. has adopted a flat bar similar in every way to the dimensions of the bend bar, as it has been found that tests of tensile and bend on different sections do not correlate well. It appears logical to take the tensile strength on the same sectioned bar as the bend test bar, for then strength, elongation and bend are determined on similar cross sections, a matter of great importance in metal of the structure of malleable iron. The B.E.S.A., on the other hand, specify a round bar for tensile strength, for the round bar is used to some extent in the trade.

A flat tensile bar of the same size as that used for the bend test is preferable. Furthermore, only one pattern and one type of bar has to be dealt with in the shop, which makes for simplicity and cheapness in testing. For a range of casting thicknesses the tensile bar has to be related to the casting thickness in the same way as the bend bar, and hence for the tensile test three bars are proposed each to cover the range of thicknesses given for the bend test. It has been found from experience that there is no undue danger of such bars breaking in the grips.

The elongation figures for the $\frac{1}{16}$-in. bar would naturally be greater and for the ½-in. bar less than that given by the standard ¾-in. bar, but the exact figures would require to be settled on a basis of actual test results. The tensile and bend bars are best cast on the slope at an angle of about 30 deg., with a large head to ensure soundness.

Engineering Malleable Castings.

On the heavier side of the malleable industry, *e.g.*, in the production of castings for the engineering trades, it is essential that some stipulation be made by the buyer as to the quality of the castings in tons per square inch, elongation per cent., and degrees bend. The tests usually specified are those laid down by the accepted authority, viz., the British Engineering Standards Association, and are on bars comparable in thickness and weight to the heavier castings required in engineering.

The B.E.S.A. specification for whiteheart malleable calls for 20 tons per sq. in. tensile strength and 5 per cent. elongation (2-in. gauge length) on a round bar 0.564-in. effective diameter, and 45 deg. bend on a bar 1 in. by ¾ in. by 8 in., round a 1-in. radius. It is only in making such tests and profiting by the results that any sound understanding can be arrived at as to the quality of the castings produced.

Malleable castings meeting the above specifications are satisfactory. It is well known that crucible metal stands a better chance of producing higher quality malleable castings than does cupola metal. The reasons generally given are that in crucible melting there is less absorption of carbon and of sulphur, and that silicon losses are less during the melting period. Such metal, when made into castings, and annealed, has given as much as 12 per cent. elongation on 2 in. after good annealing. Usually in the race for output and economy, the annealing is curtailed that nothing like 12 per cent. is actually obtained. On the other hand, cupola metal castings can show systematically 6 to 8 per cent. elongation under proper annealing.

Such results are well above those demanded in the B.E.S.A. specification, so that there is no reason to fear any difficulty in meeting the tests. The elongation figures quoted above were taken as special instances, because short annealing markedly influences ductility. The elongation per cent. is therefore a good criterion of quality, although it should always be taken in conjunction with the tensile strength and the bend value.

The B.C.I.R.A. has particulars of a quite inexpensive bend test machine which has been found very useful and efficient. Such a machine enables a bend test to be made under standard conditions with ease, by hand, as distinct from the decidedly unsatisfactory method sometimes employed of hitting the bar gripped in a vice.

Whilst buyers of thin-walled malleable castings naturally prefer a high degree of ductility, there are cases where totally different properties are required to meet quite another set of conditions. Stiffness and hardness are required in many castings of the heavier type used in the motor trades, *e.g.*, such castings as splined hubs, carrying torque, stentor clips, and bearing surfaces of machinery. In the production of such castings to meet special conditions, greater regard would be paid to their ability to stand up to the particular job than to a general set of tests ordinarily meant for typical whiteheart malleable cast iron. Where very hard castings are asked for, it sometimes becomes necessary to under-anneal them intentionally or to add special elements such as manganese or chromium to assist in the hardening.

* From the October Bulletin of the British Cast Iron Research Association.

Scottish Foundrymen's Dinner.

In addition to Mr. S. H. Russell, president of the Institute, and Mr. T. Makemson, general secretary, the guests who have signified their intention of attending the annual dinner of the Scottish Branch of the Institute of British Foundrymen in the Grosvenor Restaurant, Glasgow, on Saturday, December 8, include Engineer-Commander Sidgwick, R.N. (representing the Engineer-in-Chief of the Navy); Dr. V. E. Pullin, O.B.E., of Woolwich Arsenal; Bailie Park, Senior Magistrate of Glasgow; Capt. H. J. Kennard, Bailie of Falkirk; Mr. Jas. Richardson, B.Sc., President Inst. Mechanical Engineers, Glasgow Section; Professor A. L. Mellanby; Dr. Andrew McCance; Mr. J. Jefferson, A.R.S.M.; and the presidents of kindred institutions.

The toast of "The Institute of British Foundrymen," to which Mr. S. H. Russell will reply, will be proposed by Engineer-Commander Sidgwick, R.N.

Ingot Mould Design.*

By Ralph H. Watson.

Molten steel poured into an iron mould freezes in three distinct phases. The first is a very thin skin of fine-grained crystals. This is followed immediately by the well-known columnar crystals approximately perpendicular to the mould wall, which grow inward as long as influenced by the chill of the mould. They end rather abruptly, and the third phase, the formation of equiaxial crystals, then completes the solidification. This crystallisation, as well as the other two phases, takes place, as would be expected, roughly parallel to the walls of the mould and stool. Crystal growth, both in the case of the columnar and the equiaxial crystals, is by the process of selective crystallisation. The purer crystals separate out first, causing the mother liquor to be progressively enriched until the last to freeze carries a considerable enrichment of carbon, phosphorus, manganese, sulphur, and other constituents of steel. This is segregation. Molten steel takes up more room than the metal solidified. The outer wall of the ingot is formed approximately at its final size, while the interior of the ingot is still molten. The freezing is progressive from the outside. The final deficit in volume occurs along the central axis. This is pipe.

In the course of some remarks on the question of mould taper the author points out that big-end-up moulds for rolling-mill ingots have been given considerable taper. This is undesirable from a rolling standpoint, and of doubtful necessity. One reason advanced for large taper is that the ingot through vertical shrinkage settles down nearer the mould walls, and receives more chilling effect from the mould. When the time required for full vertical shrinkage is considered, and also the fact that the ingot should never make complete contact with the mould and cause a hang, the chilling effect becomes doubtful. Many successful forge moulds have small taper. Although the big-end-down mould with the large taper, even with the hot top, cannot be regarded as successful, this mould with the small taper equipped with a hot top is very promising.

A hot top should have heat insulating qualities sufficient to keep the steel contained molten for the necessary period. It should either release the ingot or itself sink with the contracting ingot to prevent hanging. It should be made of a material that will not flake or spall when subjected to the heat of the stream when top-pouring, and thus introduce foreign matter into the ingot. It should leave on the ingot nothing that will subsequently melt in the soaking pits, and run down over the surface of the ingot. It should be easily applied to the mould, and not be too costly. None of the tops in present use altogether meets these requirements. The single-piece hot-top brick is the one in greatest favour. Other tops are made of sand, coke, old brick crushed, bricks of various shapes, blast-furnace and open-hearth slag poured into forms, and blast-furnace slag bonded and formed into shapes.

Mould-Wall Thickness.

Opinion on mould-wall thickness is at great variance. Ingots of approximately the same size are cast in moulds varying from 2½ in. to 14 in. thick at the top. Usually there is a differential between the top and bottom thickness from consideration of economy, mould life, and effect on ingot cooling. Mr. Morris, of the Bethlehem Steel Corporation, who has had a long experience in the design of moulds for both forging and rolling ingots, has adopted the rule of making his mould at the top as thin as is compatible with the necessary structural strength for the size in question, and doubling this thickness at the bottom. Such a mould is none too easy to cast with the top up in the mould foundry, for the reason that kish separating from the iron during the pour is likely to be entrapped by the sharply converging walls of the foundry mould.

The author has been able to gather no conclusive data on the effect of mould-wall thickness on ingot surface and chipping cost. Opinion there is, probably based upon experience, but opinion at one plant is exactly opposite to that at another. Although it is not safe to generalise from meagre information, experiments indicate that during the skin-forming period, mould-wall thickness has little influence on rapidity of ingot cooling. Perhaps it is because the influence is negligible that opinion on the subject has not crystallised.

Heavy-walled moulds fire-crack more than the lighter, and it is safe to say that thickness added to the mould beyond the point where it no longer fails through cracks at the top or bottom is uneconomical from the point of view of mould life. Experiments indicate that there is always an excess of metal at the corners of a rectangular ingot mould. Experience has demonstrated that the mould may be thinned down considerably at the corner without detriment to mould life, and with a saving in weight of mould.

Mould Shape.

The tendency in the shape of ingots is to abandon the straight-sided ingot. A straight line cannot be deformed without stretching or breaking. Recent designs of ingots, therefore, are bulged or concave, corrugated or fluted. The rolling mill has again gone to the forge for its ingot. The present effort is to design an ingot with a long periphery. Quick-cooling, longitudinal ribs are thought by some to strengthen the ingot in its early cooling stage. This is exactly opposite to the view that is held by those who strive for uniform cooling of the ingot. Their contention is that the good effect of these mould shapes comes entirely from the greater area, and therefore strength of surface.

One of the most successful ingots, used by several makers of high-grade steel, is the twelve-sided fluted ingot. It has the advantage of the yielding periphery, and if the quick cooling saliences do nothing more, they limit the length of horizontal cracks. Unless it is the result of a hanging ingot, a horizontal crack seldom extends beyond the corner. The twelve-sided ingot limits the length of a crack to one-twelfth of the periphery, where a square ingot may allow it to extend to one-quarter. Fluted, concave and bulged ingots have the additional advantage over the flat ingot of a slight compression of the skin during the early passes in the mill, which is beneficial to the weak skin at that period. This is more marked if the ingot fits the pass and has collar support. For ordinary blooming mills, the unequal-sided ingot is preferable to the square. The ingot should fit the first pass in the roll on its narrow side. The difference in length of side should be the reduction given before the first manipulation. In this way the ingot can be given collar support for all four sides in the first roll pass. This cannot be done with the square ingot.

In no feature of mould design is there less agreement than on the point of corner radius. Radii vary in approximately the same-sized ingot from 1-in. to 6 and recently 8 in. From the standpoint of operations, there is considerable advantage in the large radius. Ingots pour with cleaner corners, cool more uniformly, and are in less danger of being burned in heating. The moulds can be cleaned more easily, and are less likely to be neglected at the corners. The dendritic structure of the sharp-cornered ingot is well known. Columnar crystals, forming perpendicular to the mould wall, meet in a diagonal line of weakness. Inclusions are found entrapped by the meeting crystals. Forging ingots with sharp flutes are known to crack along the points of the flute or beneath the surface.

On the other hand, advocates of the small radius point out that a round ingot is difficult to pour without cracks, and that an ingot with a large radius approaches the round. Moulds that have produced vertically-cracked ingots have been corrected by decreasing the corner radius. The conflicting advantages and disadvantages of the small and large corner radius indicate that both extremes should be avoided. There is a middle ground wide enough to allow considerable latitude, and it is not wise to correct the condition caused by one extreme by going to the other. A rule adopted by Mr. Morris, of Bethlehem, for rectangular moulds, is to make the corner radius equal 13 per cent. of the longest side, and for large moulds somewhat less.

Mould Stools.

More attention is being paid to the stools than heretofore. The contact with the mould is better, and they are equipped with guides to insure the mould sitting in the same position on the stool. A steel pourer, if he cannot trust the joint of his stool and mould, is apt to form the habit of opening up on each mould twice, the first time to test or seal the joint, the second time to pour his ingot. One splash is bad, two are unnecessary. Moulds with curved bottoms are likely to be cut by the stream in pouring. To prevent this one firm is now coating the core bottoms with a chrome coating that is retained in the mould, probably alloying to some extent with the iron.

Many big-end-down moulds for blooming-mill ingots have the dished stool. This makes a lighter bottom crop, and is said by some to lessen the likelihood of butt cracks. The butt crack is one of the most troublesome of ingot defects. It has been attributed to the dendritic cone caused by the chilling action of flat stools. This seems far-fetched, as at best only the apex of the cone could be at the height of the crack, and so deep seated that the effect would be nil. It has been attributed to the splash, and the curved bottom of the big-end-up ingot is thought to correct it by minimising the splash with the quick-forming pool. It is more prevalent in big-end-down than in big-end-up ingots.

Mould Life.

Not too much consideration should be given to mould life. If it is achieved by keeping moulds on the run too long, it is the poorest of economy. It must not be forgotten that a worn-out mould has a large salvage value. Mould cost less salvage varies from 1 per cent. to 5 per cent. of open-hearth conversion cost, depending upon type of mould, distance from source of supply, and other conditions. This means that the plant with the low mould cost can take only a one to a one hundred chance of scrapping an ingot with a worn-out mould, and the plant with the high cost only a one to twenty chance. Moulds are not infrequently thrown off the run at the stripper. This is one heat too late, and the last heat is very costly. Where the product of the ingot must be chipped, chipping costs over-shadow the cost of moulds. The records commonly kept of mould performance have been the life of the mould expressed in heats, and the pounds or cost per ton of ingots. Managers now are reading these records in a different light than formerly. Where a long mould life was commendable, it now immediately arouses suspicion when surface troubles develop.

* From a Paper read before the American Iron and Steel Institute at New York.

A Postponement.

Mr. J. M. Primrose, manager of the Grangemouth Iron Company, Falkirk, is suffering from a nervous breakdown. The Paper which he was to have read to the Falkirk Section on November 17, on "Blacking, Coal Dust and Light Castings," has been postponed to a later date.

Footballer Injured in Foundry Mishap.

As the result of an accident in Southbank Iron Works, Kirkintilloch, Daniel M'Laughlin, a well-known Campsie football player, lies in the Glasgow Infirmary. Three men, of whom he was one, were carrying a ladle of molten metal, when one of them slipped and the metal splashed on to them. M'Laughlin was badly burned about the arms and legs. The others were less seriously injured, and allowed to go home after having their injuries dressed.

The Works of Altos Hornos de Vizcaya, Bilbao, Spain.

The present company was constituted in 1902 by the fusion of the following companies: Altos Hornos y Fábricas de Hierro y Acero de Bilbao, Sociedad de Construcciones La Vizcaya and Compañia Anónima Iberia. The capital has at various times been increased and now stands at 125,000,000 pesetas (say £4,167,000).

The works occupy an area of more than 100 hectares (250 acres), and are situated in Baracaldo and Sestao on the left bank of the river Nervion, 8 and 10 km. (4.6 and 6.1 miles) respectively below Bilbao. They are near the Triano, Somorrostro and Galdames iron-ore districts, from which they draw their supplies of ore and limestone. The Company has iron-ore mines in the Galdames district, and an important share in the iron ore got by the Orconera Iron Ore Company, the Franco-Belga and also the properties of the now extinct Luchana Mining Company, Limited.

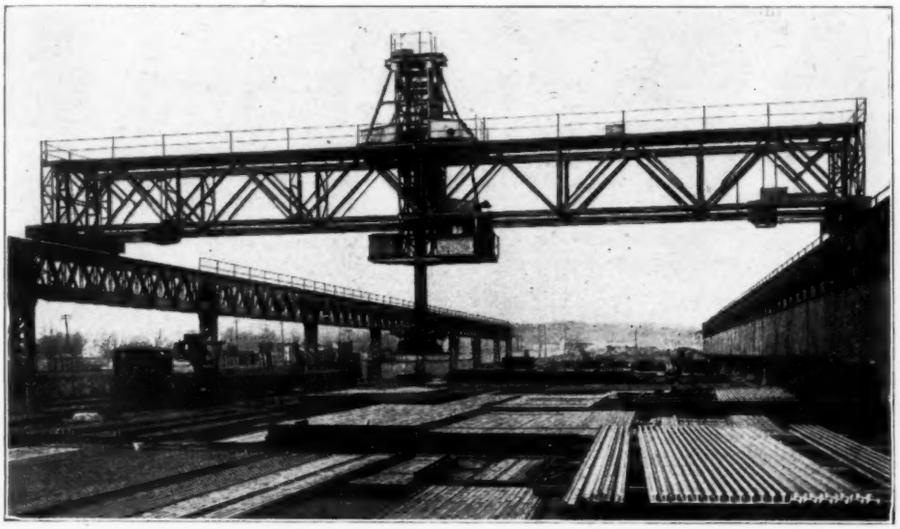


Fig. 1.—Railbank at Baracaldo Works.

As regards fuel, the Company has control over the Hulleras del Turón, S.A., in the Asturias coalfield, which produces about 500,000 tons a year, and in addition to supplying Altos Hornos, supplies also the San Francisco del Desierto Company, which also manufactures iron and steel, its plant including a battery of coke ovens with an installation for the recovery of by-products, two blast-furnaces, three basic open-hearth furnaces, rolling mills, etc.

The Company has a special contract with the Hidroelectrica Iberica for the supply of electrical energy from its power station. It owns a fleet of seven ships of a total tonnage of 29,000 tons.

Baracaldo Works.

Steam is raised in boilers fired by coal and waste gases from the blast-furnaces and the coke ovens. Electric current is produced by gas engines and turbo-generators of an aggregate total of 20,000 h.p.

There is an installation of five batteries of coke ovens of the Semet-Solvay and Simon-Carves types, with a production of 80 tons in 24 hours per battery.

There is a group of four blast-furnaces, with 16 stoves and four turbo-blowers. Each furnace produces about 250 tons of pig-iron a day, which is converted into steel by the Bessemer process. The plant for dealing with this includes a 250-ton and a 600-ton mixer.

There are two Bessemer converters, with an output capacity of 800 tons during 24 hours; a third is in course of construction.

An installation of three basic open-hearth furnaces is on the point of completion, with an output capacity of 75 tons per cast.

The electrical installation consists at present of three 3-phase A.C. motors operating at 3,000 volts, each of 2,000 kw. capacity, at a speed of 495 r.p.m., and eight continuous-current dynamos of 1,500 kw. capacity each at a speed of 440 r.p.m.

The cogging mill, constructed by Messrs. Davy Brothers, of Sheffield, has rolls of 2,750 × 1,041 mm. (9 ft. by 41 in.) and can deal with ingots weighing from 2 to 5 tons, rolling them into slabs down to 300 × 300 mm. (say 12 by 12 in.). Electrically driven, its principal motor develops 6,250 h.p. at 69 r.p.m. The mill is complete with all the necessary auxiliary plant.

The reversing mill, constructed by the German firm of Thyssen, consists of four stands. The first is a universal stand with rolls 2,600 × 850 mm. (say 8 ft. 6in. by 34 in.), capable of rolling flats 200 to 1,000 mm. (8 to 40 in.) wide. The second stand has rolls 2,100 × 850 mm. (say 7 ft. by 34 in.), the third 2,390 × 850 mm. (say 8 ft. by 34 in.), and the fourth 2,100 × 850 mm. say 7 ft. by 34 in.). In this mill, in addition to flats, joists up to 700 mm. (27½ in.), rails up to 50 kg. (100 lbs.), angles, etc., can be rolled. All the stands have Williams' manipulators. The mill is electrically driven.

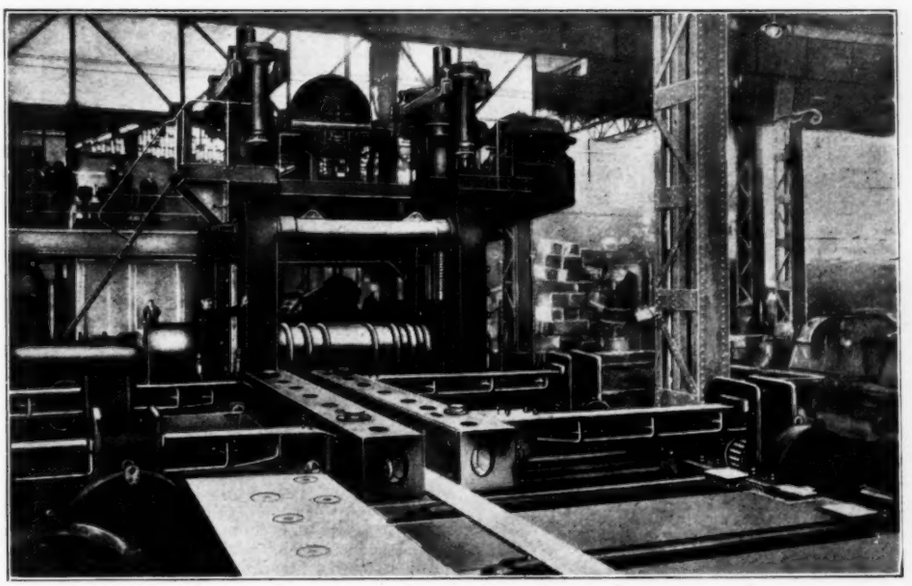


Fig. 2.—Cogging Mill at Baracaldo Works.

Section-Finishing Department.—This department covers an area of 16,000 sq. m. (4 acres), and stands parallel to the railway. It consists of three bays, 235 m. (780 ft.) long. The first, which is 14 m. (46 ft.) wide is for the reception of material from the rolling mills. In this bay are the various finishing machines for rails, fishplates, shapes, etc. In the third, which is 39 m. (128 ft.) wide, and like the first uncovered, the finished material is kept awaiting despatch.

Auxiliary Services.—For repairs and renewals there are the usual shops such as the carpenter's shop, boiler shop, fitting shop, forge, etc.

In a different building there is a testing house and a chemical laboratory with all the necessary requirements for the testing of raw materials and products. The various shops are connected by a rail network extending to more than 60 km. (36.6 miles).

The slag from the blast-furnaces is taken out to sea and sunk by three 600- to 800-ton steam barges.

Sestao Works.

In 1882 was founded in Bilbao the Sociedad Anónima Metalurgica y Construcciones La Vizcaya with a share capital of 12,500,000 pesetas (say £417,000). The works are situated on the left bank of the river 2 km. (1.22 miles) from the Baracaldo Works, and connected by the Company's own railway and other means of communication both by land and water.

There are four Simon-Carves type and two Semet-Solvay type coke-oven batteries, capable of a total output of 670 tons of coke per 24 hours. Attached to these there is a plant for the recovery of by-products.

There are three blast-furnaces with 11 Cowper stoves, and four blowers, with a daily production of 250 tons of iron per furnace; and eight open-hearth furnaces with a production of 20 to 25 tons per cast, with all auxiliary plant.

The rolling mills are housed in various bays covering an area of 38,000 sq. m. (9.4 acres), and comprise cogging, section, plate, sheet and wire mills complete with all the necessary auxiliary apparatus.

A continuous mill is installed in a steel building of four parallel bays 25 to 27 m. (82 to 88.5 ft.) wide × 185 m. (607 ft.) long. This mill was put to work in 1919. The continuous section of it consists of nine stands driven by two electric

motors of 600 and 1,000 h.p. respectively. The semi-continuous section consists of a 400-mm. (15.5-in.) medium-sized mill with five stands and a small 300-mm. (12-in.) mill driven respectively by a 1,000- and a 600-h.p. motor.

Each mill has its corresponding cooling bed 60 m. (200 ft.) long, and all the necessary auxiliary machines.

The forging department occupies three bays 130 × 52 m. (426 ft. by 170 ft.). The central bay contains two presses of 2,000 and 800 tons capacity respectively. In the other bays are housed the

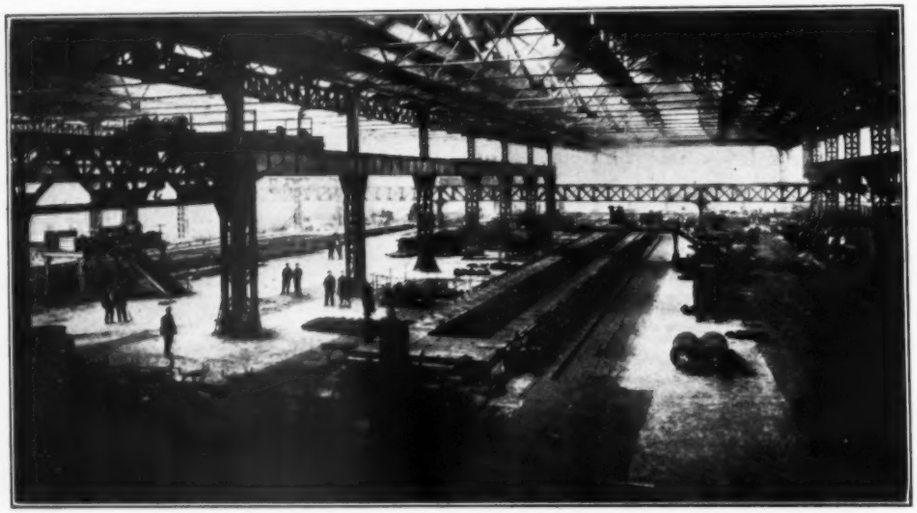


Fig. 3.—Continuous Mill at Sestao Works.

reheating and annealing furnaces, and auxiliary machinery.

The finishing departments include tinplate works, the galvanised and corrugated sheet department and the bucket-manufacturing shop.

The Company has devoted much attention to the welfare of its employees, and has created and maintains such institutions as schools for the instruction of employees' children, a savings bank, first-aid centres and a surgical sanatorium to comply with the accident regulations, and clinics in charge of specialists for the treatment of eye, throat and nose troubles, etc., as well as a special clinic for women for the free treatment of wives of employees. It also maintains a pension fund for the widows and orphans of employees.

Economies in Oxy-Acetylene Cutting for Riser Removal.*

By Glenn O. Carter.

The oxy-acetylene cutting of risers is such an important part of steel-foundry work that in the last few years it has had a fair share of attention. There are, however, many phases of the application where practices have not been standardised.

In many foundries one cutter is expected to take care of all; in practically all foundries the cost per ton of product has been reduced in the last five years. On the other hand, the very ease with which risers and gates may be removed has resulted in increasing the cross section to be cut, and this tends to increase the cost of cutting per ton of finished product.

Because cutting is a part of the manufacturing system it must go along in reasonably close step with the output just as the sand blasting or cleaning must be done. This puts a premium on "getting out" the work as compared with efficiency of cutting.

In many foundries one cutter is expected to take care of all work, but because the cost of the gases is much greater than the labour cost, it may pay to aim for maximum efficiency rather than tonnage. The cost of gases for cutting steel 5-in. thick is approximately eight times the labour cost and for steel 10-in. thick it approximates sixteen times. As thickness increases the ratio of gas cost and labour cost increases.

There is still another factor that enters into this problem of efficient cutting yet the figures do not always appear in studies of cutting costs. The grinding of the castings to remove all traces of risers, gates and fins is another considerable item of cost, and closeness of cutting affects the grinding very materially.

Certain practices advocated by the author in a Paper† read before your Society several years ago are recognised as being just as suitable now. To supply oxygen and acetylene through pipe lines was then the practice in a few foundries. It is now general. Oxygen cylinders are connected to manifolds that are conveniently located for handling of cylinders. Acetylene is generated on the premises from calcium carbide and is supplied at suitable pressures up to 15 lbs. per sq. in. (Never in excess of this for safety reasons.)

Connecting apparatus to single cylinders brought into the cleaning room is seldom done now because of the cost of extra handling of cylinders and the possibility of damaging cylinders from the moving around of castings.

More attention is now paid to equipment than was the case just after the war, and attention is also paid to the use of correct gas pressures. Regulators attached permanently to pipe lines or at manifolds naturally do not give the trouble formerly experienced with regulators that were being shifted many times a week from one gas cylinder to another.

The attention paid to apparatus is another result from close attention paid to costs. Sudden rises in gas consumption per unit of work has pointed to defective cutting equipment, as was noted by R. W. Thomas of the Vulcan Iron Works.‡

Another practice on which the seal of approval has been placed by many foundries is the separation of castings into groups according to size of risers, so that there will be a minimum changing of equipment and of pressures. No one blowpipe tip is suitable for cutting 5-in. steel, and also either 2-in. or 10-in. thick metal. A constant changing of tips is a waste of time and damages apparatus, although changing tips is cheaper than miscellaneous cutting with one tip.

The necessity for the proper welding tip is, of course, largely a matter of efficiency of the cutting operation, but it also greatly affects the cost of cutting. Larger tips and higher oxygen pressures than normal will greatly increase the consumption of oxygen for the same thickness of cut.

In some cases cutting blowpipes having different sizes of tips are kept hooked up so the change from one size to another is almost instantaneous. This is specially recommended where fins are cut, as they seldom require more than the smallest size of cutting jet.

The use of the oxy-acetylene cutting process has enabled designers of castings and the makers to undertake work hardly possible otherwise.

Larger risers and more pouring gates are now used than in earlier steel-foundry practice because an ample reservoir capacity above the casting is essential to compensate for shrinkage and thus prevent pipe or blowholes. The foundry is in this way surer of getting a good casting than when small risers and gates are used. The location of risers is of importance in casting, and, although it is advantageous to have risers so placed as to permit of straight cutting, this is not as essential with oxy-acetylene cutting as with mechanical cutting. Frequently such an excess of metal is used to make continuous risers, like in cylindrical sections.

For cutting materials other than risers there are a few helpful suggestions that can be offered. When the cut section is very extensive there is a heat effect that must be controlled. Cutting with oxygen does not harm the metal if the cut is reasonably smooth, but the heat may cause warping. In these cases it will pay to heat slabs before shapes are cut out with the blowpipe.

Some study has been given to the use of machine-operated blowpipes. So-called straight-line cutting machines can be used without much trouble, and much of the operator's time is thus saved in cutting on work which is fairly heavy, such as 10-in. and up. With machine control there is a decided saving in gases, and the finished work should require a minimum of grinding. This phase of cutting requires the interest and study of the manager and the superintendent, and there may be a real reward for the effort.

Another application of the oxy-acetylene process has had further study in the not distant past. The welding of defects in iron and steel castings is a serious item in all foundries. One way of facing this is so to limit the use of welding that the repaired section will not be subjected to stress. This will allow of very low-grade workmanship for mere filling-in operations, but it is not in accord with present tendencies in other directions in welding.

There is the alternative of using oxy-acetylene welding as a strength element. The steel foundries have not come to this use in any such way as some of the grey-iron foundries have. The splendid description of oxy-acetylene welding installation at certain automobile-engine casting foundries give details as to correct practices for use of welding as a strength carrying detail.

It may be that the steel foundries have not come to a full appreciation of correct welding practices beginning with qualifying of operators, the use of suitable high-grade filler materials and the use of adequate preheat.

The recent article by R. A. Bull, "When Should Steel Castings be Welded," gives a cue as to a clever and suitable way of testing workmanship. It is certain that the expense of testing is offset by the reduction in other costs. Adequate checking of welding certainly repays the management wherever welding is used.

The use of the oxy-acetylene weld as a structural element is of growing importance to the steel foundryman on the side of developing or holding business.

High-grade steel castings can be and are being joined to a pipe and plate steel by oxy-acetylene welding so as to give a finished product better than can be made by use of pipe or plate alone. The reason is that very simple, therefore, dependable castings can be made to give adequate thickness of metal at points of maximum stress. Then relatively thin sections of rolled steel can be used at high working stresses where the section would be too thin or too complicated for satisfactory castings.

* A Paper read before the Philadelphia Meeting of the American Foundrymen's Association. The author is Consulting Engineer to the Linde Air Products Company, of New York.

† Managerial Study of Oxy-acetylene Cutting and Welding in Foundries. Trans. A.F.A., Vol. 30, pp. 708–722 (1922).

‡ The International Acetylene Association in 1925.

Messrs. W. Pickersgill & Sons, Limited, Sunderland, are to build two steamers of 9,000 tons each for the Court Line, Limited, London. They will be engined by the North-Eastern Marine Engineering Company, Limited.

Bardenheuer and Zeyen's Paper Criticised.*

By J. Shaw (Southsea).

Earlier in the year the author dealt with the questionable reliability of many investigations on cast iron, when using small amounts of synthetic material. A plea was made that a cast-iron base should be the foundation for all cast-iron investigations, and that enough metal should be employed to allow all the ordinary reactions to take place normally.

It is desired at the outset to make it perfectly clear that what follows is not an attack on scientific research, or is in any way intended to belittle the efforts made at various technical institutions to clear up our problems. The limitations of their tools and finances are recognised. But practical men have such faith in their ability that they generally accept at once, without question, any new theory that meets with their approval. Their faith is at times shaken when they read of the utterly conflicting views held for the same subject of investigation, using the same materials. The only object of the previous Paper and criticism to-night is to see if we can find a common policy, so that the full confidence between the purely scientific side and the practical can be strengthened. A quotation from a recent Paper might act as a standard for both sides: "Science deals with nothing but facts, has no opinions, admits no prejudice, eliminates personal habits and preconceived ideas, analyses to the last atom, and admits nothing as a fact unless it stands the test of logical reasoning. A natural rule of action, a definite cause precedes every result."

It is here proposed to review and discuss a recent Paper by Bardenheuer & Zeyen that deals with four most important points. (1) Theory of the formation of graphite in cast iron; (2) investigations carried out with a view to influencing graphite segregation systematically; (3) effect of the development of the graphite on the mechanical properties of cast-iron, and (4) influencing the development of the graphite and the strength of cast iron by treating the melt.

As the full Paper covers 26 pages of foolscap we will confine ourselves principally to the author's actual experiments. It is hoped, therefore, that all have read the abstract published in THE FOUNDRY TRADE JOURNAL for August 23, 1928, so that the subject will be familiar.

With regard to the first point, "Theory of the Formation of Graphite," there is such an amount of conflicting evidence that no lay mind can reach a definite conclusion. The authors mention 40 investigations. According to the majority of earlier investigators the stable graphite system is evolved from the metastable carbide system, by the carbon segregating from the melt only in the form of iron carbide, which decomposes and forms graphite shortly after solidification. This view is still largely held and taught in this country. On the other hand, there are men of such standing as Benedicks, who was supported by Howe, who contend that it is possible for the graphite to be directly segregated from the melt. This view is held by many German workers. Ruer and Goerens claim that by careful experiments they were able to prove *without contradiction* that graphite segregates from the melt. The author has spent six weeks going through the majority of these investigations with little advantage. Many are conducted on such small amounts of metal, with, in some cases, an almost total disregard of oxidation, that their conclusions are doubtful. The first two experiments in the present Paper are glaring examples.

Investigations Carried Out with a View of Influencing Graphitic Segregation Systematically.

Here again the views of a number of workers are given, all of whom agree that with increasing the melting temperature the graphite is refined and strength increased. Piwowarsky sums up his views as follows:—

(1) The increasing carbide formation in solidified cast iron that is always observed with increase in the temperature to which the melt is superheated might be explained by the disappearance of the mechanical portions of the graphite and the increase of the carbide molecules in the melt; (2) the increase in the degree of refinement of the graphite which is already observed at moderate ranges of superheat, is caused by the gradual lowering of the eutectic critical temperature, as there is an increasing tendency for solidification to occur in regions of increased spontaneous nucleation; (3) the further increased refinement of the graphite observed where superheating is carried still further might then be attributed to the still further increasing tendency of the metal to cool in still wider ranges of intercooling, where the increase in the number of carbide nuclei formed is still greater, due to the gradually decreasing volumes of gases liberated from the melts.

Bardenheuer proved that on quenching samples of liquid grey iron which were heated for 10 mins. at 1,200 deg. C., appreciable quantities of graphite, generally distributed as nidæ, were always found. There is, on the contrary, no graphite in the quenched specimens after heating them for 10 mins. at 1,500 deg. C. Although the suppression of graphite by watering the molten pigs has been practised in Sheffield for over 40 years, it remained for Smalley to put it on a scientific basis (F.T.J., May 4/22). He stated definitely: "That high-carbon grey irons melted in the ordinary way always contain some free graphite." Portevin, at the Paris Convention (F.T.J., July 31/24), stated: "In the cupola melting of pig-iron the fusion is very rapid, and because of that the solution of the graphite lamellæ may not be complete, which without doubt plays an important part and helps the development of the lamellæ during solidification and produces a greyer casting." To Piwowarsky metallurgists are indebted for the theory that this graphite is destroyed by superheating. From the quoted and other references one may conclude that there is a large and growing body of investigators who believe that free graphite can exist in molten iron, some of whom also believe that it may be segregated from the melt direct. If this is granted it means a definite weakening of theory that carbide only is segregated from the melt and they offer as a proof that by running a thin stream of metal into water and on analysing the pellets, finding no graphite present is no proof. This is evidently due to some other cause such as oxidation in passing through the air as little meteorites. It means also that due to the short time and temperature needed to melt cupola metal, free graphite is seldom absent in molten cupola iron. It means that the ultimate structure depends, in cupola metal, to some extent on the size of the graphite as charged. It gives a logical answer to the question of "Why semi-steel of the same analysis as a pig-iron, has nearly always a finer graphitic structure?" It means also there is a logical answer to a few of those so-called inherent properties.

Graphite Refining and High Casting Temperature.

There is a fair amount of proof from practical sources, that with increase of temperature there is a reduction and refinement of graphite. Elliot's work points that way. The author rather questioned Piwowarsky's figures, quoted from Wedemeyer's results (A.F.A. Proc., 1926), who stated that after holding air-furnace metal for three hours at increasing temperatures, he found no loss of any element, but an increased CC from 0.82 to 1.18 per cent., and a decrease of GC from 2.12 to 1.72 per cent. Roxburgh and Green tried this out for the author on twelve 13-ton air furnace melts, using a thick slag and a neutral atmosphere. The results were as follows:—

Chill	Gain ¾ in. (C.C. about 0.22 per cent.)	On average of 2 hours held.
T.C.	Loss 0.04 per cent.	,, ,,
Si.	Loss 0.05 per cent.	,, ,,
Mn.	Loss 0.03 per cent.	,, ,,
S.	Gain 0.001 per cent.	,, ,,

No one can analyse within these figures, but they are given as the results came. Wedemeyer's figures were thus confirmed.

TABLE I.

T.C.	C.C.	G.C.	Si.	Mn.	P.	S.
2.99	0.71	2.28	1.75	0.91	0.069	0.024
3.38	0.81	2.57	1.69	0.67	0.44	0.078
3.47	—	3.47	3.32	0.55	0.05	0.023

Let us now examine the first two of Bardenheuer's experiments in order to study the dissocia-

TABLE II.—*Melted in Open Tammann Furnace.*

MELT 4

Temp. Deg. C.	T.C.	G.C.	C.C.	G.C./C.C.	Unetched.	Etched.
1,200	3.01	2.17	0.84	72.09	Coarse and fine graphitic carbon ..	G., F., P.
1,300	2.89	2.16	0.73	74.74	Ditto	Ditto
1,400	2.87	2.27	0.60	79.09	Graphite eutectic	G.E., F.P.
1,500	2.84	0.89	1.95	31.34	Graphite eutectic at edge, white areas in centre.	G.E., F., P., Led.
1,600	2.55	2.12	0.43	83.14	Graphite eutectic	G., F., P.
1,700	2.63	2.17	0.46	82.51	Graphite eutectic, white areas	G.E., F., P., Led.
1,800	2.18	1.01	1.17	46.33	Ditto	G.E., F., P., Led.

ORIGINAL METAL.

T.C., 2.99; G.C., 2.28; C.C., 0.71; Si., 1.75; Mn., 0.91; P., 0.068; S., 0.024.

CUPOLA IRON 5

1,200	3.36	2.62	0.74	77.98	Coarse graphite flakes	G , F., P., P.E.
1,300	3.24	2.56	0.68	79.01	Graphite flakes	Ditto
1,400	3.25	2.58	0.67	79.38	Graphite flakes	Ditto
1,500	3.23	2.59	0.64	80.19	Gr. flakes in eut. arrangement	Ditto
1,600	3.04	2.58	0.46	84.87	Ditto	Ditto
1,700	2.91	2.17	0.74	74.57	Gr. flakes with white areas..	G., F., P., Led., P.E.
1,800	2.87	2.31	0.56	80.49	Gr. flakes in eut. arrangement	G., F., P., P.E.

ORIGINAL IRON.

T.C., 3.38; G.C., 2.57; C.C., 0.81; Si., 1.69; Mn., 0.67; P., 0.44; S., 0.078.

SYNTHETIC METAL 6.

1,200	3.47	3.33	0.14	95.97	Coarse graphite	G., F., P.
1,300	3.40	3.33	0.07	97.94	Slightly finer graphite	Ditto
1,400	3.33	3.16	0.17	94.90	Ditto	Ditto
1,500	3.41	3.36	0.05	98.53	Fine Gr. commencing to form eut... ..	Ditto
1,600	3.26	3.06	0.26	93.87	Eut. gr. and small white areas	G.E., F.P., Led.
1,700	3.31	3.29	0.02	99.40	Pure graphite eutectic	G.E., F., P.
1,800	2.93	2.88	0.05	98.29	Ditto	Ditto

ORIGINAL IRON.

T.C., 3.47; G.C., 3.47; C.C., nil; Si., 3.32; Mn., 0.55; P., 0.05; S., 0 023.

* A Paper read before the London Branch of I.B.F., Mr. W. B. Lake presiding. An abstract of the original ("Graphite in Grey Cast Iron") Paper appeared in our issue of August 23, page 133, *et seq.*

tion of graphite when melting grey iron. Taking No. 2 first, because the analysis of the metal is given at the various temperatures. It throws light on the first set of experiments. The material in Table I (Table III in the *F.T.J.*) was used to investigate the influence of overheating on the development and quantity of graphite with slow cooling.

The middle iron was a cupola iron, the others from pure initial materials. Two and a half ounces of each iron was used for each experiment. For melts up to 1,500 deg. C. the crucibles were of hard porcelain. For temperatures of 1,600 deg. C. "Pythagorus" refractory. While for temperatures of 1,700 and 1,800 deg. C. fused magnesite was used. Each melt was slowly heated up to the required temperature, held at that for 15 minutes, current shut off, and allowed to cool down in the furnace. A second series was also carried out in vacuum, but the whole of this part of the Paper is so open to criticism that the author will content himself with an examination of the results obtained in the Tammann furnace.

From the figures of Table II herewith it will be immediately noticed that there is a reduction of T.C. with each type of metal. As there is no mention of dilution in this portion of the Paper, one can only conclude it is due to oxidation. This would also have a serious influence on the amount of the silicon and manganese, especially the high silicon. As the irons melted in vacuum also show a considerable drop in total carbon, dilution may have been employed, but this again would lower all the other elements present. Most of the breaks in the combined and graphitic carbon content occur where there is a change of crucible from one material to the other, at 1,600, 1,700 and 1,800 deg. C., showing what a vital influence the material of the container has on these small amounts of such a heterogeneous material as cast iron. Two examples of this are given in Table IV of Bardenheuer's Paper. The original silicon would, however, be considerably lower if either dilution or oxidation on the scale of the carbon is allowed for. In the case of melt 5 it would only be about 1.25 per cent., showing a clear pick up of silicon of 0.69 per cent. from the crucible at the highest temperature. There is no doubt this would account for the reverse in the curve found by Piwowarsky and Klingenstein at 1,500 deg. C.

(To be continued.)

Book Review.

Standard and Tentatively Adopted Methods of Testing and Grading Sands as Recommended by the Committee on Moulding-Sand Research, and Approved by the American Foundrymen's Association. Published by this body from 222, W. Adams Street, Chicago, Illinois, U.S.A. Price 3 dollars.

The question of moulding-sand control is obviously of greater import on a Continent like America than in a comparatively small country like Great Britain, but nevertheless, it is becoming of increasing importance, and it is more than desirable that founders should familiarise themselves with the work so far accomplished by the American Foundrymen's Association. Generally speaking, the conditions obtaining in this country are chaotic, as many workers have formed their own standards, whilst others have utilised American apparatus, whilst a few others are experimenting with German methods. The book under review is a clear, concise statement of the present position of affairs in the States, and one must admit that they have proceeded along the line of rational development much further than any other body. The scope of the book has been designed to include the following phases of the subject:—Determination of moisture; permeability (divided into 21 sections and sub-sections); compressive strength; fineness test; chemical analysis; standard tests for strength (bar tensile and shear); strength of baked core sand; dye adsorption and sintering tests; grading classification; and a directory of American testing apparatus manufacturers. Finally, there is an excellent bibliography on the subject. A phase of activity not dealt with in the book is that of mould-face hardness testers—an important practical aspect of sand testing.

A Note on the Vitreous Enamelling of Cast Iron.

By Our Metallurgical Correspondent.

Whilst the art of enamelling cast-iron articles is of comparatively recent origin, the extensive demand for enamelled cast-iron hollow-ware, including baths, sinks and other domestic fittings, has raised the industry to one of considerable magnitude. That successful enamelling is truly an art requiring considerable skill and practical experience will be admitted on all sides and detailed experience reveals many features which so far have not yielded satisfactorily to scientific explanation. Apart entirely from considerations of the composition of the enamel mixtures or batches and the firing or application of the enamel, numerous possibilities of defects in the final enamel coating exist, which can only be attributed to the metallurgical characteristics of the cast iron enamelled. Individual opinions on the nature of many of these defects vary, and their cause and existence have not been subjected to the fierce light of discussion before our various technical bodies and in our technical journals.

Inherent Properties.

Practical experience in the manufacture of enamelled goods reveals certain features which are undoubtedly of particular interest to the foundry industry generally. One of these features is the evidence that enamelling experience affords of those elusive properties which in this country we speak of as the inherent properties of pig-iron. It is probable that the belief represented by the phrase "inherent properties of pig-iron" can be expanded into the belief that different brands of pig-irons possess qualities and properties which are not necessarily revealed by either their ordinary chemical analyses or fractures and in particular that more than one brand of iron can exist having the same ordinary chemical analysis and presumably the same fractures, yet possessing different qualities and behaving differently under given circumstances.

There are many in metallurgical circles who feel that such beliefs are untenable, but it is probably true that few foundrymen are to be found who would not be prepared to agree that such beliefs can be substantiated.

What controversy exists regarding the inherent properties of pig-iron arises out of the difficulty of tracing conclusively back to the pig-iron the small differences in quality which go to make up the alleged inherent differences. In other words the whole belief is largely a matter of individual experience and opinion. More concrete form has been given lately to these beliefs by the suggestion that the method of preparation of the pig-iron is to be associated with the inherent properties, and it is asserted that the product of slow-driving furnaces has different qualities to the product of the more modern fast-driving furnaces which are not to be accounted for by the differences in the ordinary chemical analyses.

Defects Traced to Pig-Iron Used.

Much of the experience in the production of enamelled goods lends considerable colour to this belief, and it is a fact that the mere change of the brand of pig-iron can be associated with percentage of rejects due to defects in the enamelling. There are definite cases on record where, after careful trial, a change from pig-iron produced in fast-driven furnaces to material produced under conditions of slow driving within the same limits of chemical composition have resulted in the reduction of defectives to a sufficiently large extent to warrant the extra price usually demanded for these latter irons. The only interpretation that can be made of such experiences is that they are evidence of the existence of inherent properties.

The enamelling defects themselves are almost as elusive as the previous considerations in respect of pig-iron. The principal defects met with in finished enamelled articles are pinholes, blisters and cracking, flaking or chipping of the enamel layers. The latter defect is often referred to as "crazing," and in its most elusive form exists as very fine cracks or hair cracks visibly distributed throughout the enamel coating.

Free Carbon and high Sulphur.

With the exception of free or graphite carbon, there is no evidence that any of the constituents in themselves exert any influence on the formation of blisters. It is asserted that the presence of excessively high sulphur in cast iron is responsible for pinholes. To what extent this influence of sulphur is to be attributed to its influence in increasing the tendency to form shrinkage holes in the casting, or to any influence of local segregation of sulphide constituent might have in reaction with certain constituents of ground coat enamels has not been decided. Free graphite present in the iron may react with the metallic oxides present in the enamel coating and the resulting oxides of carbon gases evolved may produce blistering.

Blisters and pinholes are, of course, closely related, and for the most part a pinhole is simply the hole after the bursting of a blister. In the early days of the enamelling industry, this blistering was the cause of considerable trouble and there was an old belief the white irons only could be enamelled successfully. Whilst it is true that white irons do enamel very satisfactorily with proper care and attention being given to the condition of the surface and the composition of the ground-coat, grey irons give equally satisfactory results. It is usual to give the castings a preliminary firing or heat treatment previous to sand blasting. This treatment removes any carbonaceous organic matter from the surface of the iron.

Differential Expansion a Possibility.

With reference to cracking, flaking or crazing of the enamel, it is often very difficult to decide to what extent this is due to the enamel itself or to the material of which the casting is composed. There are, of course, many possible causes of this due to the composition of the enamel coating which fall outside the scope of this note. One of the most common causes of this defect is to be ascribed ultimately to the behaviour of the casting during both heating up and cooling down after the firing operation. These considerations are further complicated by the design of the particular casting. For instance, in a casting presenting widely varying sections of material, the thicker portions do not heat up so readily as the thinner portions, and require a longer interval of time to assume a uniform temperature. In cooling down, exactly the reverse is the case, and the thicker portions cool slower and not so readily as the thinner sections. The effect of this is that the ground coat enamel is in danger of not satisfactorily fusing on the thicker portions resulting in a poor bond at these portions in cooling down the enamel layers become rigid on the thinner parts more quickly than the whole of which conditions tending to set up stresses in the enamel coating ultimately causing cracking or flaking. This tendency is also increased by the distortion which takes place in the actual casting.

Volume Changes.

A study of the vast amount of work which has been done on the behaviour of cast iron on heating and cooling draws attention at once to the volume changes which take place. It cannot fail to have been noticed that the volume changes are not regular with increasing temperatures and also that there are vast differences in the magnitude of the volume changes in different irons. There is no doubt that these volume changes play a very prominent part in the cause of the crazing of the enamel coating, and this has been referred to in the exhaustive study of enamelling undertaken by the Bureau of Standards (Tech. Paper No. 142). From the practical standpoint once it is granted that the volume changes in heating and cooling down play an important part in the "crazing" defects, the comparatively erratic behaviour of cast iron in this respect leaves the manufacturer of enamelled cast-iron ware, none other but the empirical method of selecting his material. Under these circumstances, in the absence of strict scientific explanation of the causes of his particular defects the various brands of pig-iron available for this class of work must inevitably be classified on the basis of their inherent properties established by actual experience.

A Short Paper Competition.

The October meeting of the Newcastle Branch of the Institute of British Foundrymen was held at the Neville Hall, Newcastle-upon-Tyne, and took the form of a competition.

MR. C. GRESTY, President, said that there had been a large influx of new members as a result of the propaganda work of the last two months. The Junior Section also, he was glad to say, was also making progress.

He had pleasure in announcing that no fewer than twelve members had sent in Papers* for the competition, and he hoped to be able to get full Papers from those members at some future date. In view of the good response, they had decided to give two prizes for the competition instead of one. One of the Papers had been written by a young man who had only been a member of the Institute for a fortnight.

A vote by ballot was taken to decide the winning Papers, the first prize being awarded to No. 12, "Venting, Chaplets and Feeding," by Mr. P. Reece, and the second prize to No. 10, "Castings for 'Nowt,'" by Mr. James Bell. It was decided that the discussion on the prize-winning papers should be postponed until the last meeting of the session, when they could be read by the authors.

Training of Apprentices: Past and Present.

BY A. D. KIRBY.

One of the gravest problems confronting the British foundry industry in the near future will be the dearth of really efficient craftsmen. Anyone whose work has kept them in touch with the actual working of the foundry, during the last 20 or 25 years, must admit that craftsmanship is slowly but surely deteriorating, due to a variety of causes.

The introduction of moulding machines has to a great extent made inroads in the foundry, and with the co-operation of the patternmaker simplified the manufacture of several types of castings, which previously were hand moulded, and demanded a considerable amount of skill. Castings of intricate design are now continually being moulded by machines, which 20 years or so ago would have been thought impossible, and it is difficult to visualise the future possibilities.

One outstanding fact, however, is that moulders will always be required for finishing off and assembling moulds made by machines, and also moulding throughout certain jobs which cannot otherwise be made than by hand moulding.

Granting that the moulding machine has to a great extent contributed to the lessening of the standard of skilled craftsmanship, it is realised this is inevitable, as no one can, or wants, to stem progress in so far as production is concerned, but many actually view with alarm the none too distant future when they will be faced with a shortage of skilled and efficient craftsmen. A cause over which industry has complete control is the *practical* training of the apprentice, and compared with the opportunities afforded the apprentice of 20 to 30 years ago, the modern youth is being sadly neglected in his practical training.

Though the boy of to-day has more facilities for a better technical training than was formerly the case, yet he has not as good a chance for a sound practical training as his predecessor had. Before "mass production" was heard of, an apprentice was given a job to make, and was allowed practically his own time in which to make it, the foreman expecting, and usually getting, a first-class job. The boy of to-day is caught up in the vortex of an incessant clamour for more and more output.

In some shops he is soon put to work piecework, and the inevitable consequence is that if he is not very carefully controlled he will tend to "scamp" his work. How often does the temptation assail a boy to leave alone a part of his mould which has got broken, saying to himself it will get put right in the fettling shop.

Somehow or other the boy of to-day does not seem to take the pride in his craft that previously appertained, and undoubtedly piece-work in the early stages of his apprenticeship is one of the reasons for this state of affairs. Piece-work should be universally abolished in the foundry for all boys until they attain the age of 19 years or so, by which time they should be able to both ram up, and finish, a mould satisfactorily if they are of average intelligence.

No hard and fast rule can be postulated, as some boys develop their abilities more quickly than others, and the matter could be left to the management to lower this age if he found any boy particularly competent.

* The Papers were as follows:—(1) "Training of Apprentices, Past and Present"; (2) "A Cylinder Problem"; (3) "Training the Modern Boy in the Foundry"; (4) "Control of Cast Iron in the Jobbing Foundry"; (5) "A Few Notes on Moulding"; (6) "The Importance of a Correctly Made Pattern"; (7) "Internal Strains and Contractions"; (8) "A Few Green Sand Opinions"; (9) "Cast Iron for Heavy Oil Engines"; (10) "Castings for 'Nowt'"; (11) "Dry Sand Moulding"; (12) "Venting, Chaplets and Feeding."

A Cylinder Problem.

BY F. ALLEN.

Some time ago the author was confronted with a perplexing little problem in connection with a new design of winch cylinder, which was required to withstand a test of 360 lbs. cold-water pressure. Practically all these cylinders are machine-moulded and cast horizontally, there being several designs from which in normal times over 200 per month are cast. If half a dozen of these were returned in any one month, there would certainly be an inquest and some plain speaking.

It will readily be understood that it was with mixed feelings the news was received in the foundry that a batch of ten cylinders had failed to pass the test. To all outward appearances, they were good castings when machined, the only peculiarity about them being the appearance of a slightly darker shade in the iron in certain parts of the bore of the cylinder, in the same places in all the cylinders. When tested they invariably leaked in one or both pockets under the bolting-down lugs on the bottom side of the cylinder.

After carefully examining the core-boxes and pattern with the draughtsman, certain modifications were made in the thicknesses at certain points on the cylinder, viz.:—Where the exhaust boss joins the body and in the way of the junction of the bolting-down lugs and body, also in the partition-plate, or thickness between the steam port and exhaust. Another batch was cast, and, whilst an improvement was apparent, the result was not satisfactory, for the reason that some of the cylinders stood up to the test and others did not, in the proportion of about 50 per cent.

Finally, an arrangement of chills on the outside of the body of the cylinder, on the junction of the body and the exhaust boss, coming almost right round the boss, and also on the tips of the exhaust port cores was tried, and the next batch of castings were machined and tested, and a marked improvement was shown.

In the first place, the fixing of the chills on the outside of the casting was not a difficult matter, for by taking a block of oil-sand core and rubbing it to fit the junction of the body of the cylinder and the exhaust boss nearly to the centre line there is that outside part of the mould, an exact pattern of which is needed for the purpose of the chill.

It only remains for the moulder to rub the cake to the required thickness, giving the parts that do not face the iron in the mould the required taper for moulding. After varnishing them there is provided a pattern from which one can make dozens if required. A few brads cast in the back of the chills are sufficient to anchor them securely in position. A chill on either side of the boss ensured the desired density right round the cylinder in the way of the boss.

The question of chills for the points of the exhaust port cores was more difficult, because while there were two ways to bring the chills out of the castings, neither of them was very large, one being only 11/16th in. and the other 1⅛ in. by 4 in. long. The point was, to get a chill heavy enough to influence the freezing of the iron and yet sufficiently small to come through the small openings available.

Eventually a core was made out of the exhaust port core-box, the points sawn off, and the pieces thus obtained were used as patterns for the chills. Anchorage was again provided by casting a couple of brads in the chills. The chills were about 1 in. thick at the broadest part and about ½ in. thick in the centre. Since adopting this method with this particular cylinder, very little trouble has been experienced as far as testing or "waster" castings are concerned. Occasionally one is returned for a small gas hole in the bore, which is due to venting, and not porosity as in the first batch of castings supplied.

Many methods were tried before finally deciding that the chills were the only remedy to secure greater density of the iron in the way of the thickness between the steamway and the exhaust port, where there are two thicknesses coming together and creating a variation in thickness of two otherwise equal sections of nearly 100 per cent.

The trouble always occurred on the side of the bore cast at the bottom of the mould, and on the side in the way of the thickness which divides the steam inlet from the exhaust outlet. The only reasonable conclusion that one can arrive at as to the soundness of the top side of the casting is, that the fact of there being a riser and feeding head on the top boss ensured a quantity of fluid iron sufficient to ensure proper feeding whilst the iron was freezing.

The Control of Cast Iron in the Jobbing Foundry.

BY R. J. SHAW.

Jobbing iron-foundries which are unable to support the services of a chemist and laboratory, would find that in running a couple of standard analyses, a great improvement in their product would result, and that the constant use of a standard material would eliminate quite a few of the worries of the man-in-charge, and incidentally his customers—a very important matter in these hard times.

Having this in mind, the writer would first suggest a few analyses suitable for average engineering work, and then indicate the method of attempting to meet these with quite reasonable regularity.

Suitable analysis for cast iron for use in a jobbing iron-foundry making engineering castings will vary according to the class or grade of castings required by the majority of its customers. It may therefore happen that different foundries, though all making castings for engineers, may find it necessary to adjust the following suggested analyses, which, while "typical," are introduced mainly as necessary to the procedure to be followed, and deal with silicon, phosphorus and manganese only. Carbon and sulphur are omitted as they are not easy to control, even with the aid of a chemist; further, in the writer's opinion, sulphur is blamed, in the absence of chemical control, for a good many troubles that may well be due to some other cause.

Compositions Recommended.

(1) For moderately thin castings, with thickness varying from ¼ to ½ in.: Si, 2.5 to 2.75; P, 1.0 to 1.25; and Mn, 0.5 to 0.6 per cent.

(2) For castings with thickness varying from ½ to 1 in.: Si, 2.0; P, 0.7 to 1.0; and Mn, 0.6 to 0.8 per cent.

(3) For medium engineering castings with thickness varying from 1 to 2 in.: Si, 1.75; P, 0.7 to 0.8; and Mn, 0.6 to 0.8 per cent.

(4) For heavy engineering castings with thickness varying from 2 to 3 in.: Si, 0.8 to 1.0; P, under 0.8; and Mn, 0.6 to 0.8 per cent.

These are intended to apply to castings made in green sand, and an important point to take into consideration when a special casting is undertaken by a jobbing foundry whose practice is to run about two mixtures of iron each cast, is whether to make the job in dry sand or green sand, with the object of getting the *proper material* in it for the job.

This is quite distinct from the question of moulding in the cheapest manner, for suppose it be a casting to withstand pressure, and having an average section of ⅜ in., the foundry is usually making iron with an analysis of Si, 1.75; P, 1.0; and Mn, 0.7 per cent. In such a case, casting from a dry-sand mould would give a close grey iron which, although the silicon is low, would give a machinable casting. It follows therefore that a foundry running, say, two fairly approximate analyses, can, by using either, and making the job in either green sand or dry sand, ensure suitable material being used for the job in hand, for, although customers may like to get nice shapely castings, they are much more impressed by the casting which *does not* fail after they have spent a lot of money machining it.

Control.

Now, having decided on one or more suitable analyses, how can the jobbing founder control them within reasonable limits, without the direct everyday aid of the chemist.

One of the most fruitful sources of trouble is the variations which occur in the analysis of the pig-iron, the silicon being the worst offender. This may be reduced by a little gentle pressure on the supplier, by demanding an analysis of each batch, and buying a reasonable quantity; but even if the usual approximate analysis of a particular brand is all that is available, a great deal can be done by using at least three different brands in the mixture. These, if carefully chosen, need not make the mixture any dearer, while it will certainly average the analysis of the total pig-iron in the mixture, and so make the control of the daily cast much more certain. A common percentage of silicon in the pig-irons should be aimed at, and the final adjustments made with steel or scrap.

A possible mixture to give Si, 2.0; P, 1.0; and Mn, 0.6 per cent. in 10-cwt. charges, would be as follows: the brands designated A B C are ordinary brands of No. 3 pig-iron.

	Si. Per cent.	P. Per cent.	Mn. Per cent.
2 cwts. No. 3—Brand A ..	3.0	1.2	0.6
2 cwts. No. 3—Brand B ..	2.7	1.0	1.0
2 cwts. No. 3—Brand C ..	2.5	1.3	0.6
1 cwt. steel..	nil	nil	nil
3 cwts. machinery scrap ..	2.0	1.0	0.6

Allowing for a 0.25 per cent. loss of silicon in melting, this would give a very close approximation to the desired analysis.

Now, suppose one brand only of these 3 per cent. silicon pig-irons had been used, and instead of being 3 per cent., as sold, had only contained 2.5 per cent. silicon, then the final silicon would have been 1.75 per cent. instead of 2 per cent.; this, in the smaller castings in green sand, would cause trouble, due to hardness.

It is, of course, possible for all three brands to be wrong at the same time, *but not very likely*, and an increase in the *number* of brands used would further reduce the risk of error.

With regard to scrap, that known as machinery scrap gives a fair average of, Si, 2 to 2.5; P, 0.8 to 1.0; and Mn, 0.5 to 0.8 per cent., but that known, as range and rainwater metal, or light scrap will give Si as high as 3.0; P, 1.0 to 1.5; and Mn, 0.5 per cent., so that some discretion must be used, and observation made of the results of the scrap material usually supplied.

Foundry scrap, gates, etc., if the foundry is running on one or more mixtures, should be kept separate, as, their approximate analysis being known, they will be a further aid in securing a closer approximation to the desired analysis. A very desirable addition is a chemical check once per week or twice per month. There is no difficulty in arranging for this, and it is not too great an expense when one considers that it may prevent the using of expensive brands of iron, or giving such poor material that dissatisfied customers result. A further refinement is to stock a small quantity of high-silicon hematite with moderate manganese, and medium-silicon hematite with high manganese, say, 2 per cent., for use as correctives.

In summarising, it seems desirable to decide the following points in their order:—(1) The most useful analysis for any general run of work; (2) the least number of mixtures required daily; (3) the number of brands of pig-iron which one intends to use; (4) the approximate analysis one intends to presume for the scrap usually used; and (5) steel can be taken as "pure iron."

Having decided these points, use a good brand of coke, weigh all materials into the cupola and, when running more than one mixture, measure as correctly as possible all the first mixture out of the cupola. This will ensure as uniform a material as is possible without daily chemical control.

Venting, Chaplets and Feeding.

By P. Reece.

Venting.

There seems to be great difference of opinion as to the need of artificial venting of dry-sand moulds. Having had a fairly lengthy experience in various classes of moulding—mostly applicable to auxiliary marine machinery of all types, the author has had the best results from well-vented moulds. Experience has shown it is unwise to trust too much to the permeability of the sand for the escape of the gases generated during the casting process. All corners of a mould are gas traps, and should be vented. Special attention should be given to the venting of moulds which are cast at a very high temperature in order to produce the sound casting which has to pass a very severe test. Venting also materially assists in the process of drying; free outlets for steam prevent a good deal of the cracks which appear on the surface of the mould.

Chaplets.

In general foundry practice there is not sufficient care taken in the use of chaplets, or the methods that could be adopted to dispense with their use entirely. Very often one sees cores held in position with chaplets that could, with very little extra work or trouble, be bolted in position. It is common knowledge to all that chaplets are very apt to weaken a casting by breaking the uniformity of the metal, by inducing blow holes in the vicinity, or by causing porous or unsound metal which results in leaky castings under pressure.

Much could be done in the pattern shop to assist the foundryman by having much larger core prints on patterns that what is invariably found at the present time. A consultation with the officials of the foundry in the making of new patterns is very advisable, as has been proved most emphatically in the foundry with which the author is associated. For an example, the old way of making cores for a cylinder in sections by running the body core up on a spindle, making the chest and steamways out of separate core boxes; then fitting together when dry with the use of chaplets between the steamways, and on the top of the chest, is now absolete for the making of the majority of cylinders. Through the enterprise of the author's manager, who designed and had made in the foundry, a half-core box with the body, steamways and chest complete. The only fitting required is to fasten the two halves together when dry, with the result that there is available a complete core which requires no chaplets whatever. The initial cost of such core boxes may be rather high, but the results obtained in the foundry are well worth it. The elimination of chaplets in cylinders is essential in the production of sound castings.

Feeding.

The importance of the proper method of feeding a casting was never greater than what it is to-day. In foundries where semi-steel castings are made, great care and skill must be used to get a sound casting. Usually the greatest difficulty in this direction is to keep the feeding head open, as the metal in the head is generally dull. As soon as the mould is poured it should be covered with dry blacking, and as the shrinkage of metal commences the head should be filled up with hot metal direct from the cupola. The size of the head and the feeding rod adequately to feed a casting should have fair consideration. The feeding rod should commence its work near the bottom of the mould where solidification first takes place and the rod gradually worked out. The error in feeding is that the rod is pushed very little deeper than the feeding head, with the result that the casting is not fed at all.

The Importance of a Correctly-Made Pattern.

By W. Cook.

In the production of castings, their accuracy and finish depends to a large extent upon the patterns. The practice of using old, or defective, patterns, and then attempting to remedy matters by relying upon the skill of the moulder or "fettler" cannot be too strongly condemned, as not only are the results unsatisfactory, but the extra labour costs entailed are certainly much more than the small initial cost of repairing the patterns.

The introduction and size of fillets is a matter which should not be left to the discretion of the moulder, as this may result in fillets being inserted in undesirable places, this being especially so in castings that are not to be machined. In addition to the introduction of fillets, rounding of corners, and the making of abrupt changes in metal thicknesses more gradual, the pattern-maker is also responsible for contraction allowances. It is misleading, when allowing for contraction, to base all calculations on a fixed constant without paying due regard to the thickness and cross section of the casting, for just as metals and alloys vary so do the constants for making the necessary allowances on the pattern. This is of the utmost importance in castings where there are holes which must be of a certain specified distance between centres. Much can be learned by the observant foundryman in this matter by comparing castings with patterns.

The pattern-maker is frequently responsible for modifications in a design, with a view to facilitating the production of a casting in the foundry, and to increase the prospects of a sound casting. He can only do this successfully, however, when he is working in close co-operation with those responsible for the work in the foundry, for it must be admitted that much remains for which the moulder is responsible. It is his duty so to construct the mould, that while it supports the metal during the time of casting its resistance is such that the contracting casting will overcome. If this precaution is omitted the casting may be ruptured, especially between adjoining sections which vary in thickness and are at an angle to each other. Thin webs cast between such sections are, however, of great advantage in allaying this trouble, although it must be understood that they are a precaution only—not a prevention. These webs should be fixed to the pattern before passing it to the foundry, but their introduction is often left to the moulder.

In castings which are long, in comparison with their depth or breadth, there is a tendency for them to warp, and an allowance has to be made when constructing the pattern which is commonly called "camber." This allowance, while it may be approximately estimated by a man who has had a great deal of experience with this class of work, can be determined accurately only by trial, it being a matter in which it is necessary to compare the casting with the pattern.

The allowance for machining is of the utmost importance, as this influences to a great extent the quantity and, what is perhaps of more importance, the quality of the work turned out of the machine shop. When the allowance is incorrect it places both man and machine under a big handicap, as few things are more exasperating to the machinist than a job that will not "clean up" to size. Very often a slight modification of the pattern will result in the saving of much time and labour in this department.

It is an established fact that a defective pattern influences both the quality and the quantity of the work in every department of the foundry, and because of this the majority of foundrymen inevitably come to the conclusion that five minutes spent on the pattern is worth hours spent on the casting.

(To be continued.)

Magnesium as a Foundry Metal.

By H. W. K.

During the late war the demand for reliable light alloys for aircraft work became insistent This demand has rapidly increased rather than diminished since the war. The increasing demand is evidently due to the enormous strides made in civil and military aviation during these last ten years, and the introduction of all-metal aero and seaplanes. The Washington Naval Treaty has indirectly affected the demand, for in naval ships of a fixed tonnage light alloy metals of suitable strength have been extensively used for internal fittings, etc., in order to have reduced weight without the disposal of any important piece of apparatus.

The light metal group consists of alloys of aluminium, magnesium, and beryllium. With regard to the last-mentioned element, the general use of beryllium is not yet in practice owing chiefly to its high production costs, and until this problem is solved the use of beryllium cannot be commercialised.

At the present time magnesium is a field suitable for further metallurgical research, and this field is rapidly being thoroughly explored both in America and Germany. The large-scale production of poorer and cheaper metal is being rapidly introduced. Its production has given an impetus by the existence of the raw materials in large quantities and in a high state of purity.

The melting point of magnesium is 750 deg. C. as compared with 625 deg. C. for aluminium; also it has a higher heat conductivity at 343 (silver 1,000), whereas aluminium is 313. An important point in the physical properties of magnesium is its low specific gravity, it being on 1.74 (Al. 2.56). This is singularly important, as weight is less per unit volume compared with aluminium. If the physical properties of magnesium were the same as aluminium as regards tensile strength, etc., and casting difficulties were overcome, magnesium would rapidly replace aluminium, assuming costs production were equal.

In the best known of the magnesium alloys the weight-strength ratio is greater than the best of aluminium alloys, but not sufficiently so at present to cover questions of cost, etc. The most familiar application of magnesium is in the use of photography in the form of ribbon for flashlight work. This fact would lead one to believe it is extremely sensitive to any corrosive agent. It has been found that if impurities, of which sodium and the chlorides are the most injurious, are absent, this weakness is much reduced.

Magnesium will form alloys with copper, zinc, cadmium, and calcium, but in general practice an alloy of aluminium with 3 to 10 per cent. magnesium, known as magnalium, is usually met with.

Because of its great affinity for oxygen, it is of great use as a deoxidiser; small quantities of metallic magnesium are added to the molten metal, and a violent ebullition occurs, producing a stirring effect, which in the case of most alloys is decidedly advantageous. The result is the formation of magnesium oxide, which is very light and rises to the surface, and then skimmed off.

Magnesium alloys have gained a strong foothold in the aircraft metallurgical world. Such alloys are very light; an addition of 10 per cent. aluminium only increases the specific gravity to 1.8, and this lightness and readiness with which they are worked renders them widely applicable.

The casting and forging of magnesium is rendered somewhat difficult owing to its chemical properties, but when care is exercised it may be machined and welded. In conclusion, it may be said there is undoubtedly a great future for magnesium once these technical troubles have been overcome.

John Fritz Medal, 1929.—The John Fritz gold medal, the highest honour bestowed by the engineering profession of the United States, has been awarded for 1929 to Mr. Herbert Clark Hoover. Notable among his engineering achievements are (according to the Director of the Engineering Foundation, who award the medal) the successful introduction into other countries of improved American mining methods. It was he and his wife who translated into English Agricola's famous book "De Re Metalica."

John Wilkinson Medal Awarded.

The Junior Section of the Lancashire Branch opened the session with a meeting, held in the Manchester College of Technology on Saturday, October 27, at which the "John Wilkinson" medal was presented to Mr. J. E. Garside. It was accompanied by a book prize ("Metallurgists' Manual": Bamford and Harris) provided by the President of the Section, Mr. T. Makemson. Mr. Harold Morris, who obtained second place in the examination, was also awarded a book prize (contributed by Mr. Makemson), and four candidates who were highly commended received from Mr. J. S. Y. Primrose a souvenir in the form of a photographic reproduction of the medal.

Professor Thompson, D.Met., B.Sc., of the University of Manchester, made the presentation and gave a short but thought-provoking address. He said the offer of a prize, such as a medal, to be won in competition, often induced a man to exert the necessary extra energy in doing something which he knew ought to be done but to which he would not apply his full powers without some spur of that nature. The benefit of a competition was not confined to the recipient of the prize. All who took part gained because they had to exert themselves.

Inevitably a student would do a considerable amount of reading in the subjects to which he applied himself, especially those in which he was professionally interested. But he should take a wider range and avoid the danger of getting into a rut. A man who was concerned with a specific branch of industry or science often found himself driven on by sheer force of circumstances to devote himself to some special line whether he liked it or not, and his mind gradually got into the condition that he did not look beyond it. So the best advice to give the student was: "Let your reading be as wide as possible."

In recent years much had been said in criticism of examinations. He knew the drawbacks, and if a satisfactory alternative was proposed it would be welcomed by those who had had to examine candidates. But nobody knew a really satisfactory alternative.

In this competition the examination was not conducted on the ordinary lines, which meant writing more or less lengthy essays in reply to questions. Answers were given and the candidate had simply to indicate the correct one. It was a novel departure. The experience of it during three or four years, when it had been thoroughly tested, would be very interesting.

Mr. Garside, in acknowledging the presentation, expressed his appreciation of the way in which some members of the Senior Section helped the Juniors. He had learned a good deal through sitting for the examinations. Lines of thought were opened up in a way which did not occur through studying text-books.

A vote of thanks to Professor Thompson was moved by Mr. T. Makemson, seconded by Mr. Garside, and carried unanimously.

Mr. J. S. G. Primrose said it was an interesting fact that although John Wilkinson died 120 years ago—in 1808—there was still living a man whose father worked as cashier for him.

A claim had been made that John Wilkinson was the originator of the foundry cupola. That statement was controverted by Mr. J. E. Hurst, who had been compiling information about the origin and development of the foundry cupola, and, incidentally, had found out many things about John Wilkinson. Wilkinson was more concerned with the smeltings of small quantities of pig-iron direct from the ore and making castings from the direct metal produced; his patent was for an ore-smelting furnace and not an iron-melting cupola.

Who, then, was the originator of the foundry cupola? Mr. Hurst's answer was "John Bunyan." It would surprise most people who thought of Bunyan as the author of the "Pilgrim's Progress." Probably they knew that he was a tinker, but did not realise that the word "tinker" had a different signification in those days. Bunyan copied from the travelling gypsies of mediæval Europe the practice of going about with a horse and cart, mending pots and pans; he had a little cupola in which he remelted broken articles and cast the homely utensils required.

Mr. Primrose exhibited upon the screen a number of interesting photographs, among them reproductions of two coins issued by John Wilkinson. The medal awarded in the competition is a replica of one of these. Two portraits of him—one recognised as authentic, the other said to be dubious—were also shown.

Mr. T. Makemson delivered his presidential address, the subject of which was, "The Prospects and Opportunities of Young Foundrymen." Mr. W. Jolley took the chair. He remarked that he supposed the Juniors sometimes wondered why some of the Seniors attended these meetings regularly. Well, one reason was that they learned something. Often what he heard did not appear important, but when considered in the light of other things that he knew and actual experience of what was happening in the foundry could be turned to some useful purpose.

He was anxious the Section should extend its usefulness by increasing the membership, and he urged those present to try to bring others to the next meeting.

Mr. Makemson endorsed Mr. Jolley's remarks and recalled a suggestion previously made by Mr. Jolley that a member engaged in a foundry should attend to others engaged in that foundry and try to bring them into the Section. Some of the members were nearing the age of 23, which was the maximum age for the Section. He asked them to consider joining the Senior Section, if they did so they could continue attending the Junior meetings if they wished.

Mr. Makemson then gave his address.

Pleasant Surprise for Derby Foundry Workers.

A better spirit than that which prevails between the directors and employees of Qualcast, Limited, Derby, could not be wished for, and at the present time complete satisfaction reigns; in fact, so far as the employees are concerned, they are more than satisfied—they are delighted.

The firm of Qualcast, Limited, which, until quite recently, was known as the Derwent Foundry, is to-day enjoying much prosperity. The firm is full up with orders, and, as the profits this year are not behind those for the corresponding period of 1927, the directors have decided not to enforce a reduction of the wages of its workers, although this had been agreed to by the trade unions to which the foundry workers belong. The agreed wages cut, which ranged from 2s. 6d. a week for adult pieceworkers down to 5d. a week for time-workers under 18 years of age, became known to the employees on November 9, for on that day a notice was posted in the works. Now, much to the surprise of everyone employed by Qualcast, Limited, as well as to others outside, the "cut" is not to take effect.

When interviewed by a representative of the JOURNAL, Mr. V. Jobson, who is the managng director of the firm, stated that the employees would have been quite prepared to accept the reduction, as agreed upon by the unions, but, in the circumstances, he felt they should not be called upon to do so. The team spirit which exists, and the co-operation between the employers and employed, were big factors in the success of the concern, which employs over 300 people.

The great consideration and fair dealing which Qualcast, Limited, have always shown to their workers, has frequently been commented upon by trade union officials, and, in fact, the late Alderman Hutchinson, of Rotherham, who was the general secretary of the trade union to which the men belong, always attended the annual dinner of the firm and proposed the health of the directors, and, in doing so, he never forgot to pay tribute where it was due, and always spoke in very glowing terms on the splendid way the directors treated the workers.

EMPLOYEES OF Messrs. G. & J. Weir, Limited, engineers and founders, Holm Foundry, Cathcart, have distributed £400 among West of Scotland charities as a half-yearly payment from their Infirmaries Fund.

Foundry Purchasing.—XXIX.

By Eric N. Simons.

Inspecting Goods.—One may now turn to other matters associated with the handling of purchased materials. First comes inspection. Strictly speaking, all details of inspection, analysis, test, reception, and so forth, come under the heading of stores department work, but for convenience the writer will devote his forthcoming notes on storing the goods to details of stores operation and maintenance, rather than to an elaboration of the many and varied activities with which the stores department is concerned, and to discuss in this article such matters as inspection, etc.

The goods, when delivered to either the general stores or the consuming department, should be checked for quantity, quality, and conformity to specification, as indicated by the official order. This will enable any errors in number, dimensions, or material, to be perceived before too much handling has been done. Errors in weight will already have been detected by the weigh office, and the buying department will lose no time in claiming credit notes for the discrepancies from the supplier. Errors in quantity or quality, or conformity to specification, must at once be pointed out to the buying department, whence instructions will be issued regarding either the return or the retention of the faulty materials.

With their own orders. In such instances the advice notes are usually compared in the buying department with the orders in the files, and if correct, are passed on to the receiving officials, who use them as a means of checking the goods themselves, *e.g.*, for quantity, size, and weight. Tests more minute, and close inspection for quality, are left either to the laboratory or the receiving department, or to a special inspector. This method seems to the writer laborious and uncertain, and he considers it vastly inferior to the direct checking of materials with actual copies of the orders against which they have been supplied.

One other point needs to be mentioned before this comparatively short section is brought to a close. This is the necessity of numbering the goods received notes consecutively. The advantage of this is that if one gets lost, its absence from the file is at once detected, and enables the buying department to make inquiries in regard to the consignment covered by the missing ticket.

Any goods missing should be notified to the buying department at once, as should any which are unsound or damaged. One firm employs a form of advice as shown in Fig. 1. The columns marked "Price" and "Total Value" are completed in the buying department and used as a basis for making out claims on carriers or suppliers. The advantage of this is that it clarifies the situation from the buying department's point of view, and enables them to claim for shortage or defects expeditiously and accurately. Further remarks on the subject of receiving will be found in the next and following sections.

GOODS MISSING OR UNSOUND.

Supplier..... *Date*.....

Material..... *Order No.* .....

Goods missing.	Goods unsound or damaged.	Consignment.		Price.	Total value.
		Date.	Case No. or mark.		

FIG. 1.—REPORT OF DEFECTIVE OR MISSING GOODS.

ALEXANDER BROWN & CO., LTD., have this day received

From Messrs.

Goods.

A duplication of this record is retained from which all accounts are checked.

Date.	Tons.	Cwts.	Qrs.	Lbs.
Gross.				
Tare.				
Nett.				

FIG. 2.—WEIGHT SLIP AS USED IN AUTOMATIC RECORDER ON PATENT WEIGHING MACHINE.

Should the goods be such as require analysis or test, suitable samples will be required by the laboratory or the department concerned, and these should be prepared and forwarded by the storekeeper or receiving official,* after being carefully marked so that they can be identified as belonging to a particular consignment. Should any controversy arise concerning carriage charges on goods, the traffic department must be notified and asked for instructions.

A point not sufficiently appreciated is the importance of checking such materials as stationery, office supplies, and so forth. In one instance known to the writer, a thousand memorandum books, with plain pages, unnumbered, were ordered by a certain firm, each book being specified to contain one hundred pages. They were delivered, but over five hundred had been used before someone accidentally came to count up the number of pages in a book. It was found to be ten pages short. Examination proved that every book had a similar number of pages missing. In short, the buyer had been robbed of ten thousand pages of paper, or, in other words, the equivalent of one hundred books! *Verb. sap.*

Some firms prefer the receiving official to check goods over with supplier's advice notes rather than

* We disagree entirely with this procedure. A representative from the laboratory should take samples.—EDITOR.]

Storing the Goods: Relation Between Buyer and Storekeeper.

The organisation of the stores department may not be under the complete control of the buyer, and in some firms the two functions of purchasing and storing are kept entirely separate, the buyer having no authority whatever over the storekeeper. This seems to the writer an unsatisfactory plan.

When all is said, the official on whose shoulders falls the responsibility of keeping the production and other departments supplied with the goods they need, cannot arrange his work efficiently without something more than independent management of the general stores. He must have a measure of control, even if complete control is refused him. For example, he should have a right to indicate what stocks ought to be kept, to decide in what quantities they should be kept, and so forth. The size of stocks required often affects the price at which a commodity is bought. While a storekeeper with tact and imagination may work so harmoniously with the buying department that any control seems unnecessary, it more often happens that friction arises between the two bodies precisely because, being independent of each other's authority the opportunities for friction are so many. Yet a clash between these two departments can be productive of nothing but loss to the firm as a whole, and must at all costs be prevented. It is obviously absurd to render the buyer subordinate to the storekeeper, and it is inexpedient to give each independence, while expecting them to co-operate perfectly, since the very character of their work involves interference by the one that is all too likely to be resented by the other. The sane and safe procedure is to subordinate the stores to the buying department; or, rather, to entrust the management of the stores to a competent storekeeper, while making the buyer responsible for the general policy and efficiency of both buying department and stores, with ultimate authority as his instrument of negotiation.

Four Main Principles of Storing Goods.—In the storing of goods, four principal demands have to be met:—(a) The careful reception of commodities purchased and their storage, with systematic and accurate recording; (b) the careful and competent issuing of stores to responsible persons, and the painstaking, prompt, and accurate, recording of such outgoings; (c) the keeping of authentic stock accounts; and (d) the maintenance of proper contact and co-operation with the buying department.

Newark Firm's Better Year.

Recently there have been rumours that the firm of Messrs. Ransome & Marles, Company, Limited, Stanley Works, Newark, were contemplating amalgamation, but that there is no foundation for such statements was made clear by Mr. V. Sydney Woods, J.P. (chairman of the Company), when addressing the ordinary general meeting held last Friday. He said: "In view of the rumours that have been going about, it might be advisable for me to say that no proposals, whatever, have been made to this board with a view to amalgamation with any other company."

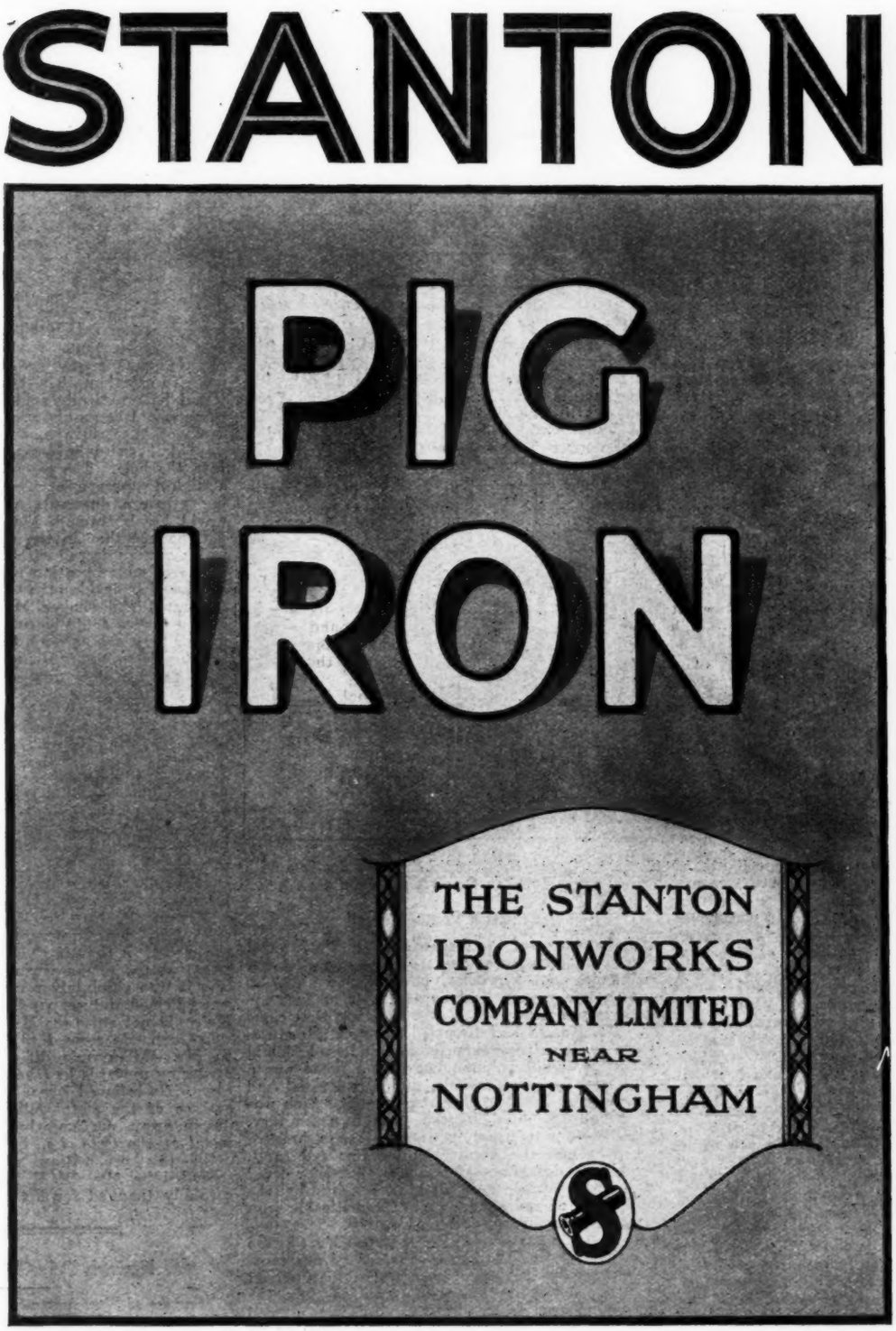
Mr. Woods said the results were slightly better than those of the previous year. Although the motor trade in general did not reach the volume anticipated by the makers, he was glad to say the increased business in the general engineering trade and abroad compensated for this. As they were aware, the capital of the Company was increased near the close of the year by the issue of a further 100,000 shares. The additional cash resources afforded by the increased capital would enable them to keep the plant in the highest state of efficiency and put them in a position to deal with an increased trade. The necessity for an addition to the working capital would be appreciated when it was realised that, in the past five years, approximately £200,000 had been expended on buildings and plant.

Future Prospects.

With regard to the present position and the prospects for the future, while trade at the moment was inclined to be slow, the order position was well up to the average at this season, and there was general feeling that an improvement in trade was to be expected. When this materialised the Company was confident they would obtain their share.

The Board, he said, recommended a dividend of 8 per cent. While the profits would warrant a large distribution, the Board preferred to continue the policy of steadily strengthening the Company's finances to put it into a position to meet all eventualities. They believed that this was in the best interests of the shareholders. He referred with deep regret to the deaths of Mr. Wade, Mr. Ransome, and Mr. J. J. Clark, their deputy-chairman.

The election of Mr. R. J. Bennett, M.P., as a director was confirmed.


STANTON
PIG
IRON
THE STANTON
IRONWORKS
COMPANY LIMITED
NEAR
NOTTINGHAM

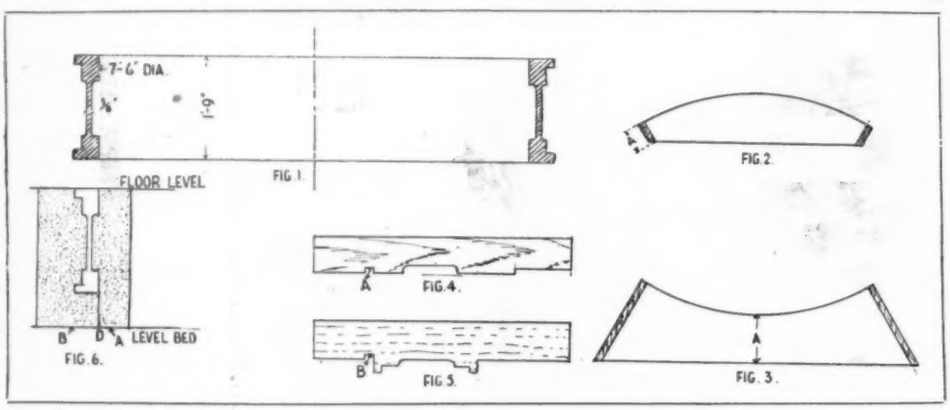
Urgent Cylindrical Casting Made in Cores.

By James Edgar.

One of several methods might be adopted for making large cylindrical castings such as that shown in Fig. 1. If a number of castings were required, either at the first order or over a long period, it would probably be most satisfactory to make a wood pattern and sweep up a full core; on the other hand, if only one casting was required, a very common way would be to make the job in loam. When a job of this kind is required urgently, however, the use of cores to form the complete mould is worthy of consideration. Not infrequently the time occupied in the production of such a casting is more important than the cost, and making use of cores generally enables more men to be employed, reducing the time occupied in production but increasing the cost. In this instance the use of cores not only speed up the job but enable it to be made cheaper than it would be in loam and yet there are many foundries in which the making of a mould by cores is seldom or never done.

The casting shown in the illustration is of simple design, but, if there were ribs and bosses, they would not affect the efficiency of the method. When the patternmaker has made a full size drawing he decides on the number of cores that will be necessary or advisable. For a casting of the size illustrated the sectional cores will be convenient to handle if they are made one-eighth of the diameter. It is better if the core-boxes are less rather than more than one-eighth to facilitate assembling them in the foundry. The core-boxes necessary are framed core-boxes, being open at both top and bottom. A sectional view of the core-box for the cores A, Fig. 6, is shown in Fig. 2, and a sectional view of the core-box for the cores B, Fig. 6, in Fig. 3. The core-boxes must be the full length of the casting plus the length of core-print. The radii of the core-box ends can be obtained from the full-sized drawing and strickles have to be made, as shown in Figs. 4 and 5, which ride on the ends of the core-boxes. The guide for the strickles, Fig. 4, which is for the inner core-box, is indicated at A and for the outer core-box strickle in Fig. 5, by B. The strickles are made of timber about 1½ in. or 1¼ in. thick, and should be chamfered on both sides. With regard to the depth of cores for a comparatively large job like this the core-boxes would need to be at least 4 ins. at A A (Figs. 2 and 3).

The construction of the two core-boxes and the strickles should not occupy, for an urgent job of this kind, when the work can be divided, not more than an hour or two, but accuracy must be observed or the moulder's work will be increased when he assembles the cores. If the foundry were at some distance from the pattern-shop, it would be advisable to outline the shape of the metal on both strickles; if pattern-shop and foundry are near each other this would not be so necessary, as the patternmaker could be in attendance on the moulder during the time of assembling the mould in order to check the cores in position.



In the foundry, the moulder would first make all the cores necessary. They are readily made on a plate, and, since the upper surfaces are the surfaces against which the metal will come in contact when assembled, they can be given a facing-wash whilst green. There should be little difficulty in preparing all the cores in one day to be dried and ready for assembling to be cast the second day. When the cores have been dried it is necessary to prepare a level bed on which a diameter D (Fig. 6) is struck. Some moulders would prefer to assemble the inner ring of cores first, and others the outer cores; it does not matter which procedure is adopted as long as care is observed. The top must be checked with a diameter gauge stick when assembled and sand rammed against the cores both outside and inside. Inside the ramming should not be too hard to facilitate venting and to allow the cores to yield as contraction takes place. The top of the mould should be on the floor level and a flat cover used with suitable runners.

Defects in Castings.

A meeting of the Birmingham, Coventry and West Midlands Branch of the Institute of British Foundrymen was held on Thursday, November 8, at the Engineers' Club, Waterloo Street, Birmingham. Mr. F. G. Starr (Branch-President) was in the chair.

A Paper,* which has already been published in the Foundry Trade Journal, was read by Mr. P. A. Russell, B.Sc., of Leicester, dealing with "Shrinkage Holes in Small Grey Iron Castings."

Hot Spots a Prolific Cause.

In the course of the discussion, Mr. F. J. Cook described the Paper as one after their own hearts. Shrinkages and blowholes, he said, were due to innumerable causes, and as a matter of fact one might hold an inquest on every casting that came up. Mr. Russell had discussed many of the causes of the troubles they experienced, and he had laid particular emphasis upon hot spots. That was a very usual cause of trouble, and Mr. Russell had mentioned a method of overcoming it which was not usually adopted in the grey iron foundry, although it was usual in the malleable branch, and that was the application of raw red sand. People looked askance at the idea that they could get over some of these little difficulties by the application of red sand, whilst in malleable iron casting it was an everyday occurrence. The question of hot spots could not be considered too seriously. It was the cause of 50 or 60 per cent. of the troubles they experienced. He was inclined to think, however, that more troubles than the author appeared to attribute to them were due to gases given off from the moulds or cores or to steam. It was an easy matter to determine which was the case. When the defect was due to steam they got a smooth hole, and it was highly coloured. It had a glazed blue appearance, whereas if it was due to gases from the metal or sand the appearance was not so highly coloured. Mr. Russell had not dealt with a trouble which occurred quite frequently as a result of bad melting, that was to say oxygen or oxides in the metal. Blowholes were often due to the fact that the chargers on the cupola had not kept the coke charges right. Probably they missed a layer of coke and got down into an oxidising atmosphere, which was a very prolific cause of blowholes. Another point mentioned by the author but not emphasised related to pouring temperature. Casting temperature was a very important matter to watch, particularly with metals of a low silicon content. The manganese had the good effect of making the metal dense. For one thing it was a great deoxidiser.

Mr. D. Wilkinson said draw holes could always be overcome by efficient feeding. The trouble, of course, was the feeding of the metal into the shrinkage hole. It was a well-known fact that molten metal contained occluded gases. He differed slightly from Mr. Russell and Mr. Cook with regard to a hole shown on one of the slides. Assuming they had a hole forming by shrinkage in the centre of a mass of semi-molten metal. All round the core there would be a skin of metal, and, of course, a skin round the outside. A small, irregular contraction hole was forming. What was going to happen? In the rest there was a certain amount of dissolved gas which would remain in solution. The hole, in the ordinary way, would be practically void of gases. Consequently there would be an absence of pressure which would draw off a certain amount of the gases, which would otherwise be occluded, and they would go into the hole. The gases would, of course, be at a high temperature. They would expand, creating pressure outwards and the pressure of gas would break through the skin and make a hole. He thought that in the case of many draw holes which communicated with the exterior of the casting, the communication was made by the pressure of the gas inside the cavity, gas which had evacuated from the molten metal, and which in the ordinary way would be occluded in the metal, forcing its way out through the hot spot and so leaving the hole. A hole, he added, could not possibly be formed against gravity.

Author's Reply.

Referring to some of the points raised in the discussion, Mr. Russell said he agreed with Mr. Wilkinson that in some cases occluded gases, oxide gases, played a considerable part in a draw, because they were evolved and under pressure and came to the surface. He thought, however, from a purely academic point of view, Mr. Wilkinson was labouring under a delusion in the way in which he visualised the action. Mr. Wilkinson contended that the draw hole, which was to all intents and purposes a vacuum, drew the gases out of the metal. He (Mr. Russell) pointed out, however, that the gases were evolved at the heat of the metal, so that if they were drawn out of the metal at the temperature of the metal by a suction it was absolutely reversing the process if the gases immediately expanded and created pressure. He could not quite see Mr. Wilkinson's point. The exact opposite seemed to be what happened. As to Mr. Wilkinson's difficulty about draw holes occurring upwards he (the speaker) had seen many cases. He believed it was due to the tension of the surface of the metal following behind the metal drawn away, particularly in the condition of the metal at the time, *i.e.*, half pasty.

On the proposition of Mr. T. H. Turner, seconded by Mr. D. H. Wood, Mr. Russell was cordially thanked for his address.

*See Vol. XXXVIII., p. 55 *et seq.*

Newark Prize Distribution.

Success of Worthington-Simpson's Cricket Club.

During the past season the cricket club run in connection with the firm of Messrs. Worthington-Simpson, the Lowfield Foundry, Bolderton, Newark, has had a very successful time, and at the annual concert and prize distribution, held at the Turk's Head, Bolderton, on Friday evening, there was a gathering of nearly 200 of the firm's employees. Mr. J. T. Graham, the works manager, presided.

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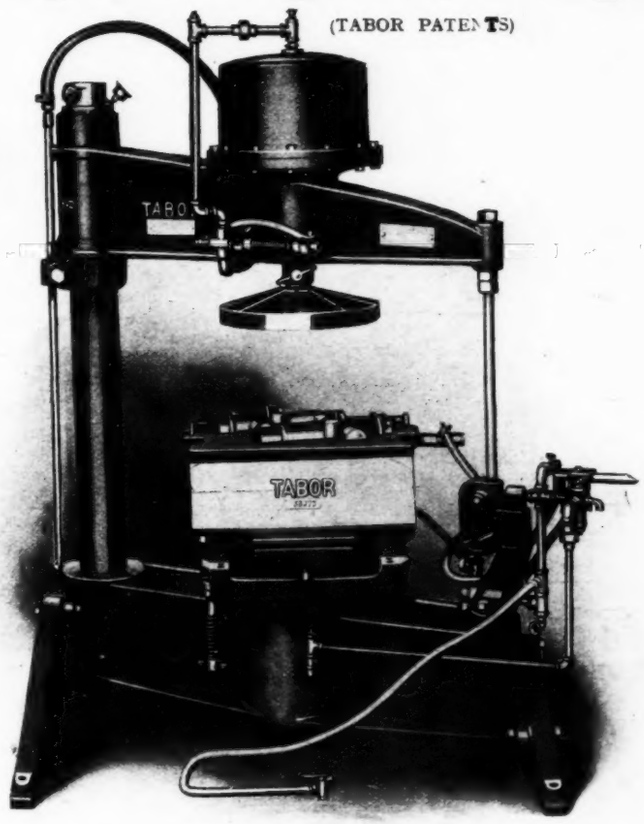

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Trade Talk.

The British Engineering Standards Association has submitted a petition for a Royal Charter.

An order for two cargo steamers has been placed by Messrs. Allan, Black & Company, Limited, with Sir James Laing & Sons, Limited, Sunderland.

The Newcastle office of the English Electric Company, Limited, has been removed from 64/68, Collingwood Buildings, to Carliol House, Newcastle-on-Tyne.

Messrs. John Readhead & Sons, Limited, South Shields, have secured a contract for the construction of two cargo steamers for Messrs. Frank C. Strick & Company, London.

The Midland Wire Rope Company, Hucknall, have appointed the firm of Messrs. Thos. Vickers, 14, New Street, Birmingham, as their selling agents for the Midland counties and for their export trade.

Messrs. Greaves, Bull and Lakin (Harbury Works), Limited, have concluded negotiations for the acquisition of an allied undertaking, which, it is stated, will materially increase their profit-earning capacity. No further issue of capital will be necessary in relation to this acquisition.

Following the decision to close the Rosedale branch on the London and North Eastern Railway, owing to the working out of the Cleveland iron-ore mines in the district, it is announced that Messrs. Thos. W. Ward, Limited, of Sheffield, have been entrusted with the work of dismantling.

An extraordinary general meeting of Messrs. William Beardmore & Company, Limited, was held on November 9 in London, Lord Invernairn presiding, when the resolutions relative to the scheme of reorganisation passed at the extraordinary general meeting on October 25 were unanimously confirmed.

An order for tramway equipment, totalling over £100,000 in value, has been placed by the Glasgow Corporation with the Metropolitan-Vickers Electrical Company, Limited. It covers the supply of complete electrical equipments for 300 tramcars which are being reconstructed to give increased speed and economy of operation.

At the Hotel Cecil, London, on November 10, Mr. and Mrs. Robert A. Hopkinson gave an Armistice celebration dinner, at which a large number of guests were present. Mr. R. A. Hopkinson is chairman and managing director of Messrs. Hopkinsons, Limited, Britannia Works, Huddersfield, the well-known valve manufacturers.

Arrangements are being made whereby the Metropolitan-Vickers Electrical Company, Limited, will acquire a holding in the British Thomson-Houston Company, the Edison & Swan Electric Company, and Messrs. Ferguson, Pailin, Ltd. Additional working capital is being raised by the Metropolitan-Vickers Company by means of a further issue of shares to the present holders of ordinary shares, and a change in the company's name is contemplated.

Mr. R. S. Johnson, managing director of Messrs. Cammell Laird & Company, Limited, speaking at a luncheon following the launch of a vessel, last week, said the firm's yard at Birkenhead had enough work on hand at the present time to carry operations over the whole of the winter, giving employment to practically all their regular employees. The yards had fourteen ships in hand. They were employing 8,000 men, the largest number at any time in the last ten years.

Messrs. Sir W. G. Armstrong, Whitworth & Company, Limited, have secured an order for ten locomotives and tenders for the Great Western of Brazil Railway Company, Limited. These locomotives will be manufactured at their Scotswood works, and are to be shipped to Pernambuco in fully-erected condition in one of the locomotive and carriage carrying vessels constructed by the firm especially for this class of work. It is also announced that Messrs. Armstrong, Whitworth & Company have effected the sale of a steam cargo vessel of 6,540 tons to the Stag Line, Limited, North Shields.

To perpetuate the memory of the late Mr. C. P. Markham, the founder of the Staveley Coal and Iron Company, Limited, a tablet has been erected in the centre of the company's Devonshire works. The tablet was unveiled by Mr. Sam Berresford (secretary and director), before a large gathering of employees. Sir William Bird, the chairman, said men were remembered more by what they did than by what they said, and those great works were the best memorial to their late chairman. Mr. Markham, he said, was a great man, who had done great things. Everyone respected him and held him in the very highest esteem.

Orders for six cargo steamers, each of about 6,180 tons, have been placed with Clyde shipbuilding firms by Messrs. H. Hogarth & Sons, Glasgow. Two will be built and engined by Messrs. David & William Henderson & Company, Limited, Partick; two by Messrs. Lithgows, Limited, Port Glasgow; one by Messrs. Napier & Miller, Limited, Old Kilpatrick; and one by the Ardrossan Dockyard, Limited, Ardrossan. The machinery for the Port Glasgow, Old Kilpatrick and Ardrossan vessels will be provided by Messrs. John G. Kincaid & Company, Limited, Greenock, and Messrs. David Rowan & Company, Limited, Glasgow—two sets by each firm.

The annual dinner of the London Iron and Steel Exchange, which this year will be held at the Hotel Metropole, on November 27, should be more than usually successful. Mr. Watson Slack will occupy the chair, and not only will Mr. L. S. Amery, the Minister for the Colonies and the Dominions, be present, but the guests will include a number of gentlemen intimately associated with the iron and steel trades. Among those present will be Sir Charles Wright, the Master Cutler of Sheffield and Mr. L. D. Whitehead, and representatives from industries allied to the iron and steel trades have also accepted invitations. Usually the attendance at the annual dinners of the London Exchange is limited to 150, but this year it is expected that this number will be exceeded. Members of the Exchange who have not yet obtained their tickets should apply to the Secretary, Mr. J. C. Sumption, London Iron and Steel Exchange, Imrie House, King William Street, London, E.C.4.

Sir George Sutton, Bt., chairman of Messrs. W. T. Henley's Telegraph Works Company, Limited, in the course of an address to the Royal Society of Arts, described the circumstances which led to the origin of the Cable Makers' Association, an organisation which has recently been severely criticised. At an early stage in the cable-making industry, he said, the firms became acutely conscious of numerous problems, and also of the opposition between the need for a high standard of quality and the desire for cheapness. They also realised that there was nothing to distinguish, in the sight of the ordinary buyer, a high-grade cable from a low-grade one. There was an obvious danger that unregulated competition would make price the sole consideration in cable contracts, and would thus bring about a steady deterioration in quality. In order to avert this danger the leading firms came together twenty-nine years ago and formed an association primarily for the purpose of fixing and adopting standards of dimensions and quality in electric cables. To-day these standards were recognised all over the world. Users of cable might denounce "rings" in more or less emphatic language, but they appreciated the vital importance of quality in cables, and they realised the value of the guarantees which the Association was able to give. Moreover, the security which combined action gave to the firms concerned enabled them to keep abreast of, and, indeed, ahead of, the needs of a rapidly expanding and changing industry. It would have been impossible for the industry to undertake this development work if it had not enjoyed the security and the financial resources which a measure of combination afforded.

New Companies.

Glynn Bros., Limited, Park Royal, Acton.—Capital £200,000. Lead manufacturers, etc.

Regent Malleable Castings, Limited, Bradley, near Bilston.—Capital £5,000 in £1 shares. Directors: J. Toole and H. Beach.

Harris & Evans, Limited, The Protector Foundry, Tipton, Staffs.—Capital £100. General ironfounders, etc. Director: H. C. Harvey.

Anglo-Eastern Tin, Limited.—Capital £30,000 in 2s. shares. Solicitors: Ashurst, Morris, Crisp & Company, 17, Throgmorton Avenue, London, E.C.

Hydraulic Coupling Company, Limited, 38, Gresham Street, London, E.C.—Capital £2,400 in 2,000 £1 "A" and 8,000 1s. "B" shares. Engineers, etc. Permanent directors: H. Sinclair and A. R. Vickers.

Industrial Welfare Society (Incorporated), 51, Palace Street, Westminster, London, S.W.—Council: H.R.H. The Duke of York, K.G. (President), F. S. Button, H. McMichael, E. J. Brown, H. F. Tomalin and six others.

Humfrey-Sandberg (Sales), Limited. — Capital £100,000. Manufacturers of and dealers in engines, gears and machinery of all kinds, etc. Solicitors: Herbert Oppenheimer, Nathan & Vandyk, 1, Finsbury Square, London, E.C.

Improved Metal Box Company, Limited, 50-51, Lime Street, London, E.C.3.—Capital £7,500 in £1 shares, to acquire inventions relating to the manufacture of boxes from tinplate, etc. Directors: W. E. Hughes, R. A. Byass, J. B. Hill and T. O. Lewis (nominated by the Grovesend Steel and Tinplate Company, Limited).

Contracts Open.

Barnsley, November 27.—8,200 yds. of cast-iron pipes, etc., for the Town Council. Mr. J. R. Fox, waterworks engineer and manager, Doncaster Road, Barnsley. (Fee £3 3s., returnable.)

Belfast, November 27.—Four centrifugal pumps, etc., for the Improvement Committee. The City Surveyor, City Hall, Belfast.

Brussels, November 30.—Turbine of 5,000 kw., for the Ixelles Communal Authorities. The Department of Overseas Trade. (Reference B.X. 4856.)

London, S.W., November 30.—Engine turntables, for the Bombay, Baroda and Central India Railway Company, 91, Petty France, Westminster, London, S.W.1. (Fee 10s. each, non-returnable.)

Salisbury, S.A., November 29.—Cast-iron, steel, and galvanised wrought-iron pipes and specials, for the Municipal Council. The Department of Overseas Trade. (Reference A.X. 7091.)

Swansea, November 24.—Wrought-iron fencing, for the Town Council. The Parks Superintendent's Office, 4, Mount Street, Swansea.

Wigton, November 26.—Cast-iron pipes, etc., for the Wigton Rural District Council. The Surveyor's Office, George Street, Wigton. (Fee £5, returnable.)

Personal.

Captain H. J. Kennard, R.N., managing director of the Falkirk Iron Company, has been elected a baillie of Falkirk.

Mr. Edward H. Shackell has been elected to a seat on the board and also made managing director of the Electrolytic Zinc Company (of Australasia), Limited.

Mr. Horace J. Young, Consulting Metallurgist and Chemist, of 3, Central Buildings, Westminster, London, S.W.1, has resigned his Fellowship of the Institute of Chemistry.

Mr. Walter G. Gray, managing director of the Steel Company of Scotland, Limited, has been elected a harbour ratepayers' representative on the Clyde Navigation Trust.

Mr. John Cameron, of Messrs. Cameron & Robertson, has been returned unopposed as a representative for Kirkintilloch on the County Council of Dumbartonshire. Mr. Geo. Albert Ure, of Messrs. Smith & Wellstood, Bonnybridge, has been similarly returned for Stirlingshire.

Wills.

Potter, A. H., of Leicester, ironfounder ...	£13,027
Gass, W. P., of Bolton, of Messrs. Entwisle & Gass, Limited, engineers	£25,976
Hardie, William, secretary of the Anderston Foundry Company, Limited, 69, Montgomerie Street, Glasgow	£6,034
Robb, William, retired ironfounder, formerly of the Callendar Iron Company, Limited	£29,859
Riley, J. H., of Stockton-on-Tees, director of Messrs. Riley Brothers (Boilermakers), Limited	£16,041
Hunter, W., managing director of William Hunter & Company (Shettleston), Limited, sheet iron workers, Glasgow ...	£5,627
Kennedy, Myles, of Ulverston, chairman of the Whitehaven Hematite Iron and Steel Company, Limited, Messrs. Kennedy Brothers, Limited, and the North Lonsdale Iron and Steel Company, Limited	£103,625

Reports and Dividends.

Siemens Brothers & Company, Limited.—Interim dividend of 2½ per cent., less tax.

Dorman, Long & Company, Limited.—Dividend of 6 per cent. on the cumulative preference shares, less tax, for the half-year ended September 30.

Cargo Fleet Iron Company, Limited.—Profit for year ended September 30, £92,834; brought forward, £178,219; debenture interest, £38,135; depreciation, £50,000; carried forward, £182,917.

Birmingham Aluminium Casting (1903) Company, Limited.—Profit, £20,510; brought forward, £29,593; dividend of 8½ per cent. on the ordinary shares, less tax; special reserve for depreciation, £10,000; reserve for equalisation of dividends, £10,000; carried forward, £16,540.

South Durham Steel & Iron Company, Limited.—Profit for year ended September 30, £102,866; brought forward, £137,641; debenture interest, £13,500; preference dividend to June 30, £13,500; depreciation, £50,000; dividend of 6 per cent. on the ordinary shares, £21,000; preference dividend accrued to September 30, £4,500; carried forward, £138,007.

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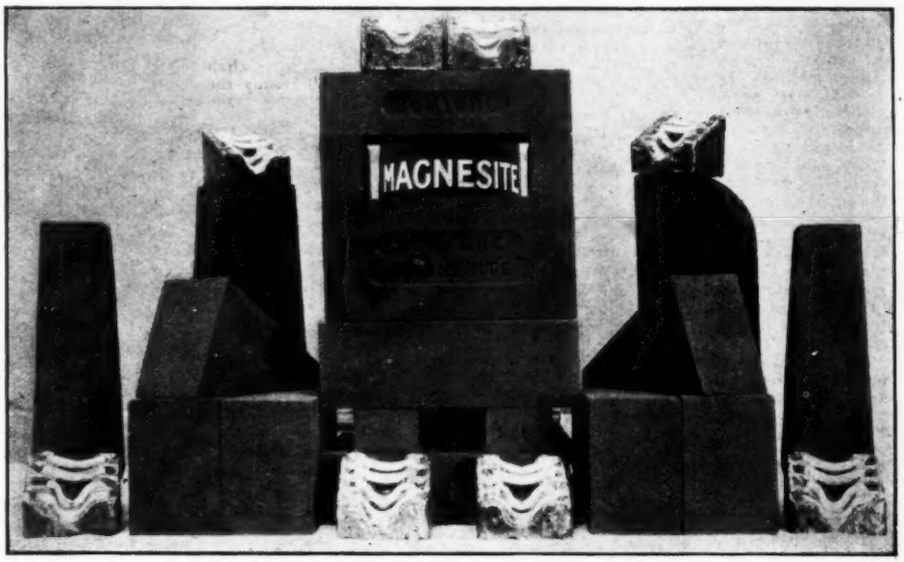

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Iron and Steel Markets.

Pig-Iron.

MIDDLESBROUGH.—Experience of previous disappointment of hopes of a substantial improvement in the conditions of the Cleveland iron trade have, perhaps, influenced an undue tendency to confirmed pessimism at the position of the industry, which may take some time to dispel. Nevertheless, it is at least satisfactory to note that some revival of active interest in buying can at last be reliably recorded during the current week, resulting from an increasing demand on home account, both the foundry and engineering industries, which previously dealt only from hand to mouth, now coming into the market with considerably enlarged orders. Consequently Cleveland ironmasters report sales largely in excess of output, while withdrawals of iron from stock were heavier than in any previous week this year, and the available reserves are dwindling so rapidly that vanishing point may soon be reached. Obviously, therefore, there are possibilities of an increase in the output in the near future, and, with so many idle blast furnaces, that is a consummation to be devoutly hoped for. On the export side, however, business is still restricted, though hopes are entertained that labour troubles in Germany may give a much-needed stimulus to a recovery in this direction. Prices remain firmly at previous levels, as follow:—No. 1 Cleveland foundry iron, 68s. 6d. per ton; No. 3 Cleveland G.M.B., 66s., No. 4 foundry, 65s.; No. 4 forge, 64s. 6d. per ton, f.o.t. or f.o.b.

The revival of activity in the steel industry has had a corresponding effect upon the Tees-side hematite market, demand at present quite exceeding output, and, with stocks practically depleted, increased production must necessarily follow, and, in fact, is now in course of immediate preparation. Prices are also firmer at 70s. 6d. for mixed numbers, with No. 1 quality at 71s. per ton at furnace. On the North-West Coast similar conditions prevail, with Bessemer mixed numbers quoted at 70s. to 70s. 6d. per ton at works.

LANCASHIRE.—The improvement in demand also extends to a certain extent to the foundry and engineering branches in this area, and a few contracts have been lately reported on forward account. Quotations are firmly held, with Derbyshire No. 3 at 68s., Staffordshire 67s. 6d., both delivered locally, and Scotch from 87s. 6d. to 90s., according to brand.

THE MIDLANDS.—In this area, though business is generally quiet, there have been a few orders placed for the makers of light castings, but without any effect upon prices, which still rule about as follow:—Northants. No. 3, 55s. 6d. to 56s. 6d.; Derbyshire No. 3, 60s.; and Staffordshire No. 3, 60s., all at furnaces, with Scotch brands 89s. to 91s., delivered locally.

SCOTLAND.—Although there is, perhaps, a more hopeful feeling prevailing in market circles, it is not possible to report that, as far as pig-iron is concerned, the demand is any better. Only small parcels are being purchased, and for these there is keen competition. At the same time, there is no weakening in prices, but traders and makers alike find the business unprofitable.

Finished Iron.

Lancashire bar-iron makers' prices are steady all round, and there seems to be little likelihood of lower values in this section of the market for the time being. There is a moderate movement of the material into consumption locally, with rather better quantities being taken in the nut and bolt industries. So far, however, there has been no necessity to increase the rate of plant operation, which continues at much below capacity. Lancashire crown bars are on offer at £10 per ton, and second-quality bars at £9 10s. Merchant parcels of crown bars are still quoted on the basis of 14s. per cwt., less 2½ per cent. and including delivery to buyers' works. Staffordshire marked bars continue firm at £12 per ton, with crown quality at £9 5s. to £9 10s. per ton, at works.

Steel.

With Continental competition practically in abeyance at the moment, the position in the steel market is better, and greater activity is in evidence. There is good business moving at Sheffield in basic billets, and the demand for acid billets shows some little improvement, although a much heavier call might reasonably be expected in the circumstances. Some makers of crude soft steel are asking about half a crown more a ton, but generally there is hesitation to make any move which might have the effect of transferring business to Continental rivals. Prices are quotably unchanged, and are:—Siemens acid billets, £9 to £9 5s.; basic billets, soft, £6 10s. to £6 12s. 6d.; hard, £7 2s. 6d. to £7 12s. 6d. In the tinplate market the home trade has become very quiet again, small transactions only being reported; 18s. f.o.t. at works is the ruling figure for usual lines.

Scrap.

Business in foundry scrap material of late has inclined to slow down, but during the current week a little more activity is in evidence in the Midlands, where there has been a good demand for all classes of cast-iron qualities, with light quoted at 55s. and heavy machinery grade at 65s. per ton delivered. In Scotland the foundries are still quiet, so that the demand for practically all classes of cast-iron scrap is poor. It is even difficult to find outlets for machinery cast iron at 65s., while ordinary heavy cast-iron scrap to the same specification is at 60s. to 61s., and cast-iron railway chairs at 64s. to 65s., with light at 58s. and cast-iron firebars at 55s. The above prices are all per ton, delivered f.o.t. consumers' works.

Metals.

Copper.—Prices for warrant copper are firmly maintained at current rates, and at the week's closing market were on exactly the same levels as those marked in the week previous, fluctuations having been almost fractional in extent. The position in the market may be summarised as favourable to a continuance of existing conditions.

Closing quotations are:—

Cash.—Thursday, £68 3s. 9d. to £68 6s. 3d.; Friday, £68 1s. 3d. to £68 2s. 6d.; Monday, £68 3s. 9d. to £68 5s.; Tuesday, £68 3s. 9d. to £68 5s.; Wednesday, £68 8s. 9d. to £68 10s. 3d.

Three Months.—Thursday, £68 12s. 6d. to £68 13s. 9d.; Friday, £68 8s. 9d. to £68 11s. 3d.; Monday, £68 12s. 6d. to £68 13s. 9d.; Tuesday, £68 12s. 6d. to £68 13s. 9d.; Wednesday, £68 16s. 3d. to £68 17s. 6d.

Tin.—Speculative interests have again been in active evidence in the market for standard cash tin, with the result that fluctuating values have been the rule in the struggle for supremacy between bulls and bears, irrespective of the claims of legitimate trade operators. This conflict of contending interests is interfering with business to a great extent, and tends to create erroneous impressions as to the real state of the metal. It is but natural that such conditions should be the rule in the tin market when the fact is taken into consideration that an extraordinarily small amount is actually known about it.

Official closing prices:—

Cash.—Thursday, £228 10s. to £228 15s.; Friday, £229 2s. 6d. to £229 5s.; Monday £230 7s. 6d. to £230 10s.; Tuesday, £231 17s. 5d. to £232 2s. 6d.; Wednesday, £233 15s. to £234.

Three Months.—Thursday, £224 7s. 6d. to £224 10s; Friday, £224 7s. 6d. to £224 10s.; Monday, £225 10s. to £225 12s. 6d.; Tuesday, £227 15s. to £228; Wednesday, £229 10s. to £229 15s.

Spelter.—In the market for ordinary spelter the only outstanding feature has been the disappearance of the contango and the substitution of a backwardation, with no apparent reason to account for such a happening. Although there is nothing particularly wrong with consumption, it has not been so good as anticipated, and hardly seems able to cope adequately with supply.

Daily quotations are:—

Ordinary.—Thursday, £24 13s. 9d.; Friday, £24 13s. 9d.; Monday, £24 13s. 9d.; Tuesday, £25 2s. 6d.; Wednesday, £25 3s. 9d.

Lead.—Although prices of soft foreign pig have remained steady and unchanged, quotations for English lead have sunk to lower levels, the decline being chiefly due to the quantities of metal coming forward being greatly in excess of anticipation. This seems to suggest that, in spite of the improvement in the statistical position recently, this market is not at bottom quite as soundly established as it appeared to be.

Soft Foreign Prompt.—Thursday, £21 5s.; Friday, £21 1s. 3d.; Monday, £21 5s.; Tuesday, £21 5s.; Wednesday, £21 3s. 9d.

Falkirk and the Light Castings Industry.

Mr. George Scotland, a director of the Falkirk Iron Company, in the course of a lecture delivered in the Union Hall, Grahamston, last Tuesday, said that Falkirk was almost totally dependent on the light castings trade, which, he was sorry to say, was at present in a very difficult position. It was surprising how few realised the extent to which the town was wrapped up in the industry. Eighty per cent. of the working population was employed directly in the foundries, and the remaining 20 per cent. were dependent upon the earnings of the foundry workers. That brought home to them what the light castings business meant to the town. It was unfortunate that at present most of the works in the district were on short time, stopping on Friday night instead of Saturday mid-day; the effect of losing this half-day was a loss of £2,000 to the workers.

It had been the proud boast of Falkirk for many years that it was the birthplace and home of the light castings industry; of the former claim no one could ever rob them, but in respect to the latter he was afraid that it could be only a few years before they would experience great difficulty in establishing the claim. The change had not occurred suddenly, it had not come in the last few months, and would not pass away in the next few. It had been coming for years—slowly, quietly, but none the less relentlessly.

There were many factors involved. One was the loss of overseas markets, an outlet which Falkirk particularly depended upon for several important lines of manufacture. As an example they might take the Argentine, which had been a rich field for several of the leading works in the district. For many years large consignments of rain water and soil goods were shipped to that country, but to-day not a ton of these goods left Falkirk for the Argentine. There were several reasons—one was the establishment of large foundries in that country. There was also the competition from Continental foundries which supplied pipes to the Argentine at prices the British foundries were quite unable to imitate.

The same position was developing in the Dominions. For example, Australia at one time was a fine market for Falkirk products; there also large works have been started which are turning out practically everything that can be made in Falkirk. When these firms discover that their goods are up to the Britsh standard they go to their Government and say "we are ready to supply the country and we want you to help us," and immediately a tariff wall of about 30 per cent. is placed against these particular British goods. That was one of the obstacles which manufacturers in Falkirk had difficulty in overcoming.

There are also troubles at home, Mr. Scotland continued, which should be remembered by the Falkirk people. Great works have sprung up in the Midlands of England, in Manchester, Leeds, Warrington, and Luton. The centre of gravity has shifted from Falkirk. Within a 75-mile radius of Manchester there was a population of twelve and a-half millions—nearly three times the total population of Scotland. That huge market could be served by motor delivery, whilst Falkirk had to contend with heavy rail charges. Motors meant a charge of four or five shillings per ton of castings, whereas the rail freight was fifty to seventy shillings a ton, and, in addition, cost of package, plus risk of breakage, plus delay and annoyance to customers.

These were some of the difficulties with which the industry had to cope. Mr. Scotland said he was not speaking as a scaremonger, but he thought it was only right, speaking with a full sense of responsibility, that the people of Falkirk should know what was developing round the town. He thought it required the concentration of the best brains in all grades of the industry to pilot it through the difficulties with which it is now confronted.

THE STEAMER "REINDEER," belonging to the Great Western Railway Company, has been sold to Messrs. Thos. W. Ward, Limited, for about £5,000, for breaking-up purposes.

THE KEY TO BETTER CASTINGS

Capponfield

Warm "W.B." Blast

THE century-old renown of South Staffordshire has been built up on its Blast Furnace practice.

Bradley's Capponfield "W.B." is a quality Pig Iron made under carefully controlled conditions to meet modern foundry requirements in the production of quality castings.

Slow-working with cool air on small output produces Pig Iron with low total carbon content and close in the grain. Its inherent properties promote that soundness and strength so essential in grain rolls, barrels and cylinders of all kinds.

3 Perfect Grades

Capponfield H.B.
(HOT BLAST)

Capponfield W.B.
(WARM BLAST)

Capponfield C.B.
(COLD BLAST)

Bradley's CAPPONFIELD PIG IRON

"Capponfield Quality"

All Capponfield Irons are direct blast-furnace products. Bradley's well-known Refined Irons are made at the Darlaston Works.

BRADLEY & FOSTER LIMITED

CAPPONFIELD AND DARLASTON, STAFFS

(All communications should be addressed to Darlaston.)

TELEPHONE: DARLASTON 16 (Private Branch Exchange). TELEGRAMS: BRADLEY'S, DARLASTON

WEEKLY PRICE CURRENT.

COPPER.

	£ s. d.
Standard cash	68 8 9
Three months	68 16 3
Electrolytic	74 15 0
Tough	72 0 0
Best selected	72 10 0
Sheets	98 0 0
India	83 0 0
Wire bars	75 2 6
Do. November	75 2 6
Do. December	75 2 6
Ingot bars	75 2 6
H.C. Wire rods	79 5 0
Off. av. cash, October	65 11 4 7/23
Do. 3 mths., October	66 0 5 5/23
Do., Sttlmnt., October	65 11 2 9/23
Do., Electro, October	72 3 5 17/23
Do., B.S., October	66 11 4 5/23
Aver. spot price, copper, Oct.	—
Do., Wire bars, October	72 8 3 5/23
Solid drawn tubes	13¾d.
Brazed tubes	13¾d.
Wire	10¼d.

BRASS.

Solid drawn tubes	12d.
Brazed tubes	14d.
Rods, drawn	11¾d.
Rods, extd. or rlld.	7¼d.
Sheets to 10 w.g.	10¾d.
Wire	10¾d.
Rolled metal	10¼d
Yellow metal rods	7¼d.
Do. 4 × 4 Squares	8d.
Do. 4 × 3 Sheets	8¼d.

TIN.

	£ s. d.
Standard cash	233 15 0
Three months	229 10 0
English	231 15 0
Bars	232 0 0
Straits	233 15 0
Australian	233 15 0
Eastern	230 10 0
Banca	233 15 0
Off. av. cash, October	222 2 1 15/23
Do., 3 mths., October	219 18 5 5/23
Do., Sttlmt., October	222 1 7 10/23
Aver. spot, October	—

SPELTER.

	£ s. d.
Ordinary	25 3 9
Remelted	23 5 0
Hard	19 10 0
Electro 99.9	28 10 0
English	25 2 6
India	20 15 6
Zinc dust	(Nom.) 35 10 0
Zinc ashes	8 0 0
Off. aver., October	24 0 7 5/23
Aver., spot, October	—

LEAD.

	£ s. d.
Soft foreign ppt.	21 3 9
English	22 10 0
Off. average, October	22 1 6 6/23
Average spot, October	—

ZINC SHEETS, &c.

	£ s. d.
Zinc sheets, English	33 0 0
Do. V.M. ex whf.	31 5 0
Rods	39 0 0
Boiler plates	29 0 0
Battery plates	30 10 0

ANTIMONY.

	£ s. d.
Special brands, Eng.	57 10 0
Chinese	40 0 0
Crude	33 10 0

QUICKSILVER.

	£ s. d.
Quicksilver	22 10 0

FERRO-ALLOYS AND STEEL-MAKING METALS

Ferro-silicon—	
25%	£7 17 6
45/50%	£12 0 0
75%	£19 0 0
Ferro-vanadium—	
35/50%	14/- lb. Va.
Ferro-molybdenum—	
70/75% c. free	4/3 lb. Mo.
Ferro-titanium—	
23/25% carbonless	1/1 lb.
Ferro-phosphorus, 20/25%	£18 0 0
Ferro-tungsten—	
80/85%, c. fr.	1/3 lb. to 1/3½
Tungsten metal powder—	
98/99%	1/7½ to 1/8 lb.
Ferro-chrome—	
2/4% car.	£30 0 0
4/6% car.	£21 5 0
6/8% car.	£20 7 6
8/10% car.	£20 7 6
Ferro-chrome—	
Max. 2% car.	£33 0 0
Max. 1% car.	£37 0 0
Max. 0.70% car.	£42 2 6
70% carbonless	1/- lb.
Nickel—99%, cubes or pellets	£175 0 0
Ferro-cobalt	9/- lb.
Aluminium 98 99%	£98 0 0
Metallic chromium—	
96,98%	2/7 lb.
Ferro-manganese (net)—	
76/80% loss	£13 15 0
76/80% packed	£14 15 0
76/80% export	£14 10 0
Metallic manganese—	
94/96%, carbonless	1/6 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	£0 2 3
Finished bars, 18% tungsten	£0 2 9

Per lb. net, d/d buyers' works.

Extras—

Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to ⅛ in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ½ in.	3d. lb.
Do., under ½ in. × ¼ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

Scrap from high-speed tool steel—

Scrap pieces	3d.
Turnings and swarf	1d.

Per lb. net, d/d steel makers' works.

SCRAP.

	£ s. d.	£ s. d.
South Wales—		
Hvy. steel		3 7 6
Bundled steel and shrngs.	3 2 6	to 3 6 0
Mixed iron and steel	3 0 0	to 3 2 0
Heavy cast iron	2 16 0	to 2 18 0
Good machinery for foundries	3 0 0	to 3 2 6
Cleveland—		
Heavy steel		2 12 6
Steel turnings		2 8 0
Cast iron borings		2 2 6
Heavy forge		3 7 6
Bushelled scrap		2 18 6
Cast-iron scrap		3 2 6
Lancashire—		
Cast-iron scrap	2 15 0	to 3 5 0
Hvy. wrought	3 5 0	to 3 7 6
Steel turnings		2 5 0

London—Merchants' buying prices delivered yard.

Copper (clean)	54 0 0
Brass	39 0 0
Lead (less usual draft)	18 10 0
Tea lead	15 10 0
Zinc	15 10 0
New aluminium cuttings	62 0 0
Brsziery copper	50 0 0
Gunmetal	50 0 0
Hollow pewter	150 0 0
Shaped black pewter	105 0 0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast—	
Foundry No. 1	68/6
Foundry No. 3	66/-
Foundry No. 4	65/-
Forge No. 4	64/6
Hematite No. 1	71/-
Hematite M/Nos.	70/6
N.W. Coast—	
Hem. M/Nos. d/d Glas.	78/-
,, d/d Birm.	85/6
Midlands—	
Staffs. common*	67/6
,, No. 4 forge	56/-
,, No. 3 fdry.	60/-
Shrops. basic	—
,, Cold blast, ord.*	—
,, ,, roll iron*	—
* d/d Birmingham.	
Northants forge	52/6
,, fdry. No. 3	55/6
Derbyshire forge	59/-
,, fdry. No. 3	60/6
,, basic	65/-
Scotland—	
Foundry No. 1	75/-
,, No. 3	70/-
Hem. M/Nos.	74/-
Sheffield (d/d district)—	
Derby forge	61/-
,, fdry. No. 3	65/-
Lincs. forge	62/6
,, fdry. No. 3	64/6
E.C. hematite	81/-
W.C. hematite	82/6
Lincs. (at furnaces)—	
Forge No. 4	58/-
Foundry No. 3	60/-
Basic	89/-
Lancashire (d/d eq. Man.)—	
Derby forge	—
,, fdry. No. 3	68/3
Northants foundry No. 3	—
Dalzell, No. 3(special)	100/- to 102/6
Summerlee, No. 3	87/6 to 90/-
Glengarnock, No. 3	87/6 to 90/-
Gartsherrie, No. 3	87/6 to 90/-
Monkland, No. 3	87/6 to 90/-
Shotts, No. 3	87/6 to 90/-

FINISHED IRON AND STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£ s. d.	£ s. d.
Bars (cr.) nom.		10 5 0
Nut and bolt iron	8 12 6	to 9 0 0
Hoops		11 10 0
Marked bars (Staffs.) f.o.t.		12 0 0
Gas strip		11 10 0
Bolts and nuts, ¾ in. × 4 in.		15 5 0
Steel—		
Ship plates	8 7 6	to 8 12 6
Boiler plts.		10 10 0
Chequer plts.		10 12 6
Angles		7 17 6
Tees		8 17 6
Joists		7 17 6
Rounds and squares, 3 in. to 5½ in.		8 17 6
Rounds under 3 in. to ¾ in. (Untested)		7 15 0 and upwards
Flats, over 5 in. wide and up		8 7 6
Flats, 5 in. to 1½ in.		7 17 6
Rails, heavy		8 10 0
Fishplates		12 10 0
Hoops (Staffs.)		10 10 0
Black sheets, 24g.	10 0 0	to 10 10 0
Galv.cor.shts., 24g.	13 10 0	to 13 15 0
Galv. fencing wire 8g. plain		12 10 0
Billets, soft	6 5 0	to 6 10 0
Billets, hard	7 2 6	to 7 15 0
Sheet bars		6 0 0
Tin bars		6 0 0

PHOSPHOR BRONZE.

	Per lb. basis
Strip	1 2¾
Sheet to 10 w.g.	1 3½
Wire	1 4¼
Rods	1 3½
Tubes	1 7¾
Castings	1 2¼

Delivery 3 cwt. free.
10% phos. cop. £40 above B.S.
15% phos. cop. £50 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. Clifford & Son, Limited.

NICKEL SILVER, &c.

	per lb.
Ingots for raising	9d. to 1/3
Rolled—	
To 9 in. wide	1/3 to 1/9
To 12 in. wide	1/3½ to 1/9½
To 15 in. wide	1/3½ to 1/9½
To 18 in. wide	1/4 to 1/10
To 21 in. wide	1/4½ to 1/10½
To 25 in. wide	1/5 to 1/11
Ingots for spoons and forks	9d. to 1/5½
Ingots rolled to spoon size	1/- to 1/8½
Wire round—	
3/0 to 10 G.	1/6½ to 2/11½

with extras according to gauge.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2X foundry, Phila.	20.76
No. 2 foundry, Valley	17.50
No. 2 foundry, Birm.	16.25
Basic	19.76
Bessemer	19.76
Malleable	19.76
Grey forge	18.76
Ferro-mang. 80% d/d	105.00
O.-h. rails, h'y at mill	43.00
Bess billets	33.00
O.-h. billets	33.00
O.-h. sheet bars	33.00
Wire rods	42.00
	Cents.
Iron bars, Phila.	2.12
Steel bars	1.95
Tank plates	1.90
Beams, etc.	1.90
Skelp, grooved steel	1.90
Skelp, sheared steel	1.90
Steel hoops	2.20
Sheets, black, No. 24	2.85
Sheets, galv., No. 24	3.50
Sheets, blue an'l'd, 9 and 10	2.00
Wire nails	2.55
Plain wire	2.40
Barbed wire, galv.	3.20
Tinplates, 100 lb. box	$5.25

COKE (at ovens)

Welsh foundry	—
,, furnace	—
Durham and North.	
,, foundry	16/-
,, furnace	14/-
Midlands, foundry	—
,, ,, furnace	13/6 to 14/6

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. Cokes	20×14 box	18/-
,,	28×20 ,,	36/-
,,	20×10 ,,	26/3
,,	18¾×14 ,,	18/9
C.W.	20×14 ,,	14/9
,,	28×20 ,,	33/6
,,	20×10 ,,	21/-
,,	18¾×14 ,,	15/-
Terneplates	28×20	33/6 per box basis f.o.b.

SWEDISH CHARCOAL IRON & STEEL.

Pig-iron	£6 0 0 to £7 10 0
Bars, hammered, basis	£17 10 0 to £18 10 0
Bars & nailrods, rolled, basis	£15 15 0 to £16 15 0
Blooms	£10 0 0 to £12 0 0
Keg steel	£32 0 0 to £33 0 0
Faggot steel	£20 0 0 to £24 0 0
Bars & rods, dead soft, steel	£10 0 0 to £14 0 0

All per English ton, f.o.b. Gothenburg

TUBES AND FITTINGS.

Up to and incl. 6 in.

	Tubes.	Fittings.
Gas	67½%	50%
Water	63¾%	45%
Steam	60%	40%

W.I. 10% extra.

DAILY FLUCTUATIONS.

	Standard Copper (cash). £ s. d.	
Nov. 15	68 3 9	No change
„ 16	68 1 3	dec. 2/6
„ 19	68 3 9	inc. 2/6
„ 20	68 3 9	No change
„ 21	68 8 9	inc. 5/-

Electrolytic Copper.

	£ s. d.	
Nov. 15	74 15 0	No change
„ 16	74 15 0	„ „
„ 19	74 15 0	„ „
„ 20	74 15 0	„ „
„ 21	74 15 0	„ „

Standard Tin (cash).

	£ s. d.		
Nov. 15	2.8 10 0	dec.	10/-
„ 16	229 2 6	inc.	12/6
„ 19	230 7 6	„	25/-
„ 20	231 17 6	„	30/-
„ 21	233 15 0	inc.	37/6

Tin (English ingots).

	£ s. d.		
Nov. 15	226 10 0	dec.	10/-
„ 16	226 15 0	inc.	5/-
„ 19	228 0 0	„	25/-
„ 20	229 10 0	„	30/-
„ 21	231 15 0	inc.	45/-

Zinc Sheets (English).

	£ s. d.	
Nov. 15	33 0 0	No change
„ 16	33 0 0	„ „
„ 19	33 0 0	„ „
„ 20	33 0 0	„ „
„ 21	33 0 0	„ „

Spelter (ordinary).

	£ s. d.		
Nov. 15	24 13 9	No change	
„ 16	24 13 9	„	„
„ 19	24 13 9	„	„
„ 20	25 2 6	inc.	8/9
„ 21	25 3 9	„	1/3

Lead (English).

	£ s. d.	
Nov. 15	22 10 0	No change
„ 16	22 10 0	„ „
„ 19	22 10 0	„ „
„ 20	22 10 0	„ „
„ 21	22 10 0	„ „

AVERAGE MONTHLY PRICES OF STEEL BOILER PLATES IN ENGLAND.

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1895 ..	5 15 0	5 15 0	5 12 6	5 12 6	5 15 0	5 17 6	5 15 0	5 17 6	6 0 0	6 0 0	6 2 6	6 0 0	5 16 10½
1896 ..	6 0 0	6 0 0	6 2 6	6 2 6	6 2 6	6 0 0	6 0 0	6 0 0	6 0 0	6 2 6	6 10 0	6 10 0	6 2 6
1897 ..	6 10 0	6 10 0	6 10 0	6 7 6	6 2 6	6 2 6	6 5 0	6 0 0	6 0 0	6 0 0	6 7 6	6 10 0	6 5 5
1898 ..	6 10 0	6 8 9	6 8 9	6 10 0	6 15 0	6 18 9	6 17 6	6 17 6	7 2 6	6 15 0	7 0 0	7 5 0	6 15 8½
1899 ..	7 5 0	8 0 0	8 2 6	8 2 6	8 5 0	8 5 0	8 12 6	8 12 6	8 15 0	8 15 0	9 2 6	9 5 0	8 17 8½
1900 ..	9 5 0	9 5 0	9 7 6	9 10 0	9 12 6	10 5 0	10 5 0	10 5 0	10 5 0	10 0 0	9 15 0	9 15 0	9 15 10
1901 ..	9 5 0	9 5 0	8 15 0	8 10 0	8 10 0	7 10 0	7 15 0	7 15 0	7 15 0	7 15 0	7 15 0	7 15 0	8 3 11
1902 ..	7 7 6	7 0 0	7 12 6	7 12 6	7 12 6	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 9 7
1903 ..	7 10 0	7 10 0	7 15 0	7 5 0	7 5 0	7 5 0	7 5 0	7 0 0	7 0 0	7 0 0	7 0 0	6 17 6	7 3 11½
1904 ..	6 12 6	6 15 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	6 18 11½
1905 ..	6 17 6	6 17 6	6 17 6	6 17 6	6 17 6	6 17 6	6 17 6	6 17 6	6 10 0	7 5 0	8 0 0	8 0 0	7 1 3
1906 ..	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 10 0	8 0 10
1907 ..	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 0 0	8 0 0	8 8 4
1908 ..	7 10 0	7 10 0	7 10 0	7 5 0	7 5 0	7 5 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 3 9
1909 ..	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	6 15 0	6 15 0	6 15 0	7 0 0	7 0 0	7 0 0	7 0 0	6 18 9
1910 ..	7 0 0	7 0 0	7 1 3	7 5 0	7 5 0	7 5 0	7 5 0	7 5 0	7 5 0	7 10 0	7 10 0	7 10 0	7 5 1
1911 ..	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 14 0	7 10 4
1912 ..	7 18 9	8 0 0	8 0 0	8 7 6	8 10 0	8 10 0	8 10 0	8 15 0	8 16 3	9 0 0	9 2 0	9 5 0	8 11 2½
1913 ..	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	8 19 0	8 15 0	8 5 0	7 15 0	7 15 0	8 17 0
1914 ..	7 15 0	7 15 0	7 15 0	7 13 9	7 10 6	7 5 0	7 0 0	8 0 0	8 2 6	8 5 0	8 5 0	8 5 0	7 15 11½
1915 ..	8 14 0	9 10 0	9 17 6	10 10 0	10 10 0	11 0 0	11 0 0	11 0 0	11 0 0	11 4 0	12 0 0	13 0 0	10 15 5½
1916 ..	13 0 0	13 0 0	13 0 0	12 15 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 12 11
1917 ..	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0
1918 ..	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0
1919 ..	13 0 0	15 0 0	15 0 0	15 0 0	19 5 0	19 17 6	21 0 0	21 10 0	21 10 0	21 10 0	21 15 0	23 10 0	18 9 9
1920 ..	26 0 0	28 0 0	28 5 0	28 10 0	29 5 0	30 0 0	30 0 0	30 0 0	30 10 0	31 0 0	31 0 0	31 0 0	29 9 2
1921 ..	30 5 0	29 0 0	25 0 0	25 0 0	25 0 0	23 0 0	21 0 0	20 10 0	19 0 0	17 10 0	16 0 0	14 16 0	22 1 9
1922 ..	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	13 1 8	13 10 0	12 15 0	12 10 0	12 10 0	12 10 0	12 6 0	13 10 9
1923 ..	12 8 9	13 6 0	14 0 0	14 0 0	14 0 0	14 0 0	13 12 6	13 0 0	13 0 0	13 0 0	13 0 0	13 10 0	13 9 1½
1924 ..	13 10 0	13 10 0	13 10 0	13 10 0	13 10 2	13 10 0	13 10 0	14 0 0	14 0 0	13 11 0	13 5 0	13 5 0	13 10 11
1925 ..	13 5 0	13 5 0	13 5 0	13 1 0	12 15 0	12 15 0	12 15 0	12 15 0	12 7 6	11 14 0	11 10 0	11 10 0	11 5 9
1926 ..	11 10 0	11 10 0	11 10 0	11 5 0	11 5 0	11 5 0	11 5 0	11 5 0	11 5 0	11 5 0	11 5 0	11 5 0	11 6 3
1927 ..	11 5 0	11 5 0	11 5 0	11 5 0	11 2 6	11 0 0	11 0 0	11 0 0	10 16 0	10 10 0	10 10 0	—	10 19 0½
1928 ..	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	—	—	—

WILLIAM JACKS & COMPANY,

WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

18, BENNETTS HILL, BIRMINGHAM.

PIG IRON

REGISTERED TRADE MARK

SCOTCH, MIDDLESBRO', HEMATITE, BASIC, SPECIALS, &c.

NON-FERROUS METALS

COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

WILLIAM JACKS & COMPANY,

19, ST. VINCENT PLACE, GLASGOW.

ZETLAND ROAD, MIDDLESBROUGH.

SMALL ADVERTISEMENTS.

Notice.

Small Advertisements in this section of the Journal are accepted at the prepaid rate of 6d. per line, first line in capitals counting two, average 6 words per line. Minimum charge for one insertion 3/-

(A remittance should accompany instructions.)

SITUATIONS VACANT AND WANTED.

PRACTICAL Foundryman desires re-engagement as Foundry Foreman (in cast iron or non-ferrous), accustomed to general heavy and jobbing work; expert knowledge of machine moulding and metal mixing.—Box 898, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

FOUNDRY PIG-IRON.—Position wanted as Resident Engineer, Birmingham or Manchester, for the direct supply from furnaces; no Agents.—Write, Box 890, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

MOULDING Machine Pattern Plate Maker, with experience of French System, Wanted at once.—State experience, age and wage required in confidence to Box 12, G.P.O., West Bromwich.

REPRESENTATIVE, with technical and sales experience, and able to estimate and quote for work, required by old-established firm of Iron and Brass Founders.—Reply in confidence, stating age, experience and salary required, etc., to Box 886, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

AGENCY.

FOUNDRY ENGINEER, with office East Midlands, is open for further Agencies; offers invited; confidential; good references; able to demonstrate.—Box 876, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

PROPERTY.

11 ACRES WORKS SITE,
SHEFFIELD.
145,000 Sq. Ft. of SHOPPING,
Compact and Convenient.
SIDING CONNECTIONS
with L.M. & S. and L. & N.E. Rlys.
WELL-BUILT & COMMODIOUS OFFICES
Will Sell whole or in lots to suit customers, or Let on favourable terms. Unique opportunity for Manufacturers.
Apply—
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